ROYAL BOTANIC GARDENS, KEW

BULLETIN OF MISCELLANEOUS INFORMATION

1940

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ERRATUM.

Kew Bulletin, Appendix, 1939. p. 693, line 19, for " east " read " west."

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BULLETIN OF MISCELLANEOUS INFORMATION No. 1 1940
ROYAL BOTANIC GARDENS, KEW

I—THE STRUCTURE AND DEVELOPMENT OF SOME APOMICTS OF TARAXACUM.

W. M. Curtis.*

Introduction.

In the genus *Taraxacum* a large number of biotypes have been recorded which, when grown under similar experimental conditions, show marked morphological differences. The biotypes now studied were grown, except when used in controlled experiments, in the open in garden soil in the Herbarium Experimental Ground at Kew, the conditions of soil, moisture and light being as uniform as possible. Seedlings of the same age obtained from the seed of one plant were grown in rows; the plants in one row were very uniform but often quite distinct in habit and leaf shape from the plants in other neighbouring rows grown from seeds of different strains. While the biotypes are morphologically distinct, there may be in any one of them a considerable degree of variation influenced by factors affected by age, by the supply of food, by light and moisture. Turrill (1938) has discussed the taxonomic status of biotypes of *Taraxacum* and has drawn attention to their plasticity. The present observations and experiments on variation in the biotypes are concerned mainly with the characters of the leaves and their variation in relation to the conditions enumerated above. The origin of the material of the biotypes used is given in the appendix to this paper, where it is shown that apomixis has been proved for two of the biotypes discussed. The leaf shape characteristic of each biotype at the time of full flowering (April-May) in the plant's second growing season, is shown in Figures 1 and 2.

Experimental Work with Plants Grown in the Open.

Variation with age.—Seeds of one apomict, Z.73, collected in May 1937 were planted the following February in a cool greenhouse. The seedlings produced 3 or 4 entire leaves: they were then transplanted to the beds in the open in full sunlight. Deeply lobed leaves were developed throughout the year. A similar sequence was obtained with the morphologically distinct apomict Z.145 when seeds were planted in June. Leaves characteristic of these apomicts are shown in diagrams 1 and 2, Figure 1.

During the second growing season a succession of types of leaf was shown. Detailed records of one plant from a row were made, involving the removal of a leaf at intervals of 14 days throughout the season. One biotype, Z.179, formed deeply lobed leaves in

* The research on which this paper is based was carried out under the aegis of the Association for the Study of Systematics in Relation to General Biology.

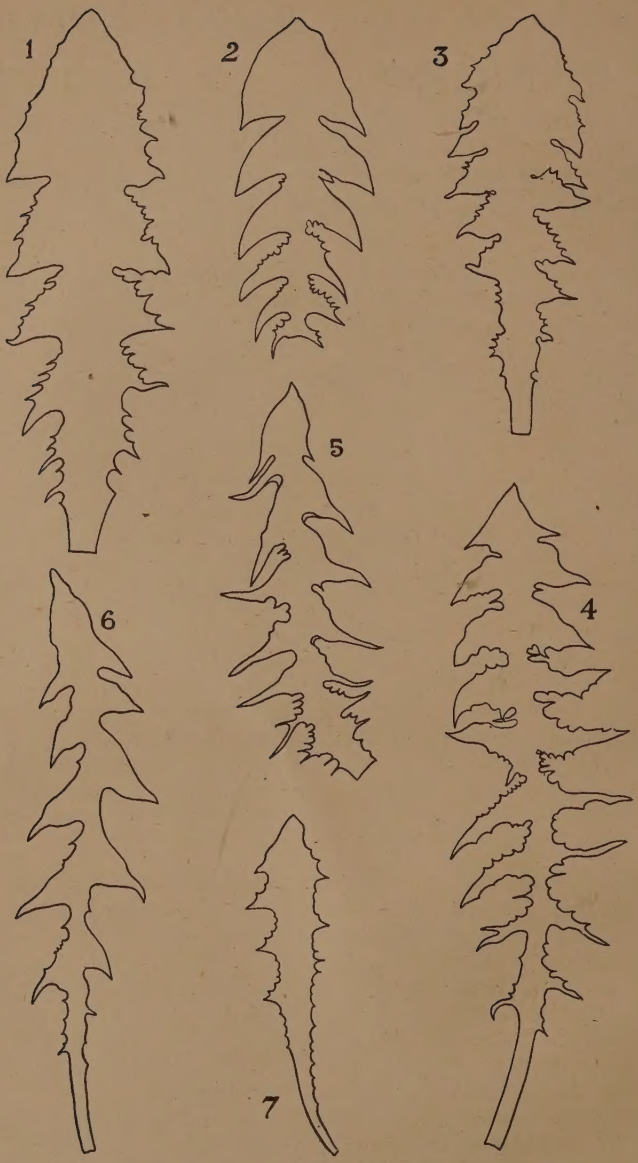

Fig. 1. Outlines of leaves of various biotypes collected at the time of full flowering in the second growing season, April–May, 1936. Reference numbers of biotypes :—1, Z.73 ; 2, Z.145 ; 3, Z.179 ; 4, Z.190 ; 5, Z.208 ; 6, Z.193 ; 7, Z.196. All diagrams $\times \frac{1}{2}$.

February 1936, which increased in size until after the plant flowered in April. A typical leaf is shown in diagram 3, Figure 1; the maximum length reached was 17 cm. When fruits formed the leaves were large but less deeply lobed and succeeding leaves were broad, spathulate and had only slightly toothed margins. In October, dissected leaves were again found and these persisted through the winter. They were, however, smaller, the maximum length being 10 cm., and less regularly lobed than the leaves found in the spring. In the third and fourth years of growth, flowering in April was associated with leaves exactly similar to, though rather smaller (maximum length 11 cm.) than, those found in the second year. This sequence is very similar to that recorded for a strain of *T. officinale* by Griffiths (1924).

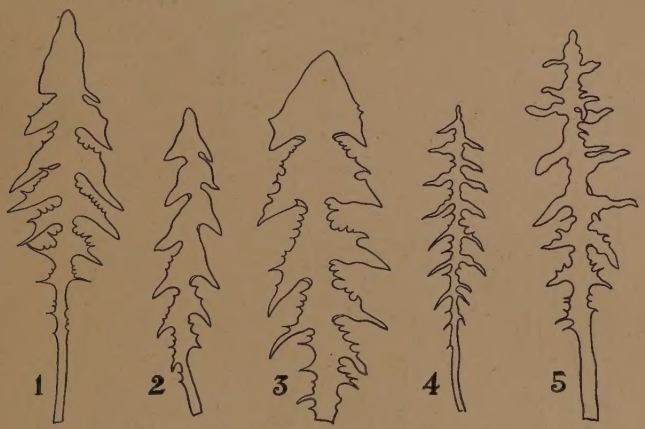

Fig. 2. Outlines of leaves of various biotypes collected at the time of full flowering in the second growing season. Reference numbers of biotypes :— 1, Z.194 ; 2, Z.301 ; 3, Z.257 ; 4, Z.282 ; 5, Z.291. All diagrams $\times \frac{1}{2}$.

The succession of leaves in five other biotypes, Z.190, Z.199, Z.208, Z.193, Z.196, recorded during their second year of growth in 1936, was from a deeply lobed type persisting until after flowering in April and May, to an entire non-dissected shape which was found throughout the autumn and winter. The lobed leaves characteristic of those biotypes in May are shown in diagrams 4–7, Figure 1. The sequence of leaves produced by the biotype Z.199 is shown in Figure 3. In two of these strains, Z.193 and Z.196, it appears probable that the persistence of the entire type of leaf was due to the removal of the leaves taken for record, since untouched plants in the same rows produced lobed leaves in October. The normal sequence in these two biotypes would then be similar to that of Z.179. A slightly different sequence was shown by a biotype Z.194 where the early spring leaves were not lobed. Here also, lobed leaves, shown in diagram 1, Figure 2, were associated with

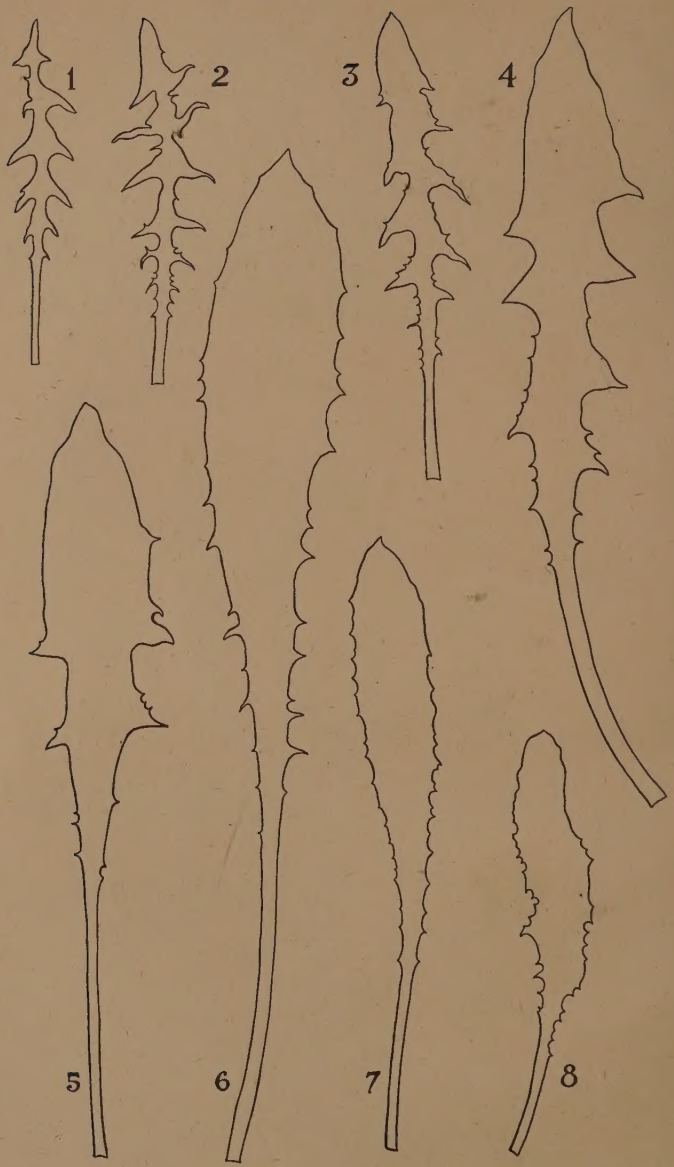

Fig. 3. Outlines of leaves collected from plant Z.199/E during the second growing season. Times of collecting :—1, 14-3-1936 ; 2, 27-3-1936 (plant flowering) ; 3, 24-4-1936 ; 4, 23-5-1936 ; 5, 3-6-1936 ; 6, 22-6-1936 ; 7, 26-8-1936 ; 8, 10-9-1936. All diagrams $\times \frac{1}{2}$.

flowering and were followed by entire leaves. The latter persisted through the winter in a plant from which leaves were removed for record, but in untouched plants were replaced by lobed leaves in the autumn.

During the third growing season all except two of the biotypes described had, at the time of flowering in April, leaves which were less dissected than those found in the second year. The lobes tended to be broader, more irregular and without any of the backward prolongations which were previously characteristic. Leaves collected from a plant of the biotype Z.199 during the third and fourth growing seasons are illustrated in Figure 4. The exceptions were the strains Z.196 and Z.179. Of these, Z.196 died after transplanting and Z.179 repeated the leaf pattern of the previous year.

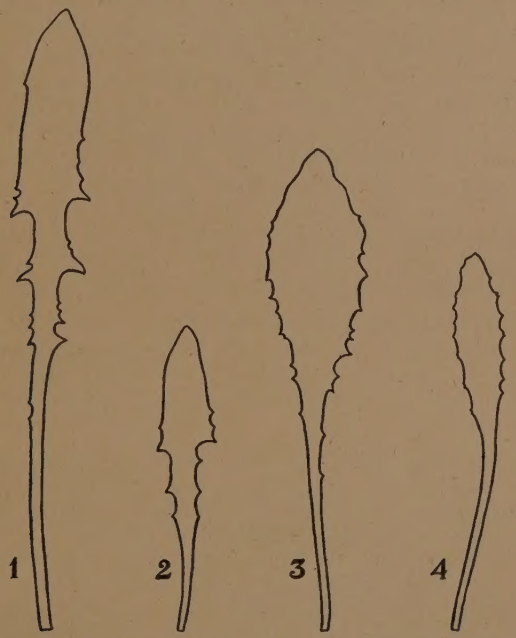

Fig. 4. Outlines of leaves collected from plant Z.199/E during the third and fourth growing seasons. Times of collecting:—1, 25-4-1937; 2, 9-4-1938; 3, 10-8-1938; 4, 14-10-1938. All diagrams $\times \frac{1}{2}$.

Older plants of strain Z.145, studied in their fourth and fifth growing seasons, had crowns divided into a number of rosettes. The leaves showed a sequence from an irregularly lobed type in the spring to a less dissected type at the time of flowering: the latter leaf shape persisted through the winter. In all plants the position of the leaves varied according to the biotype and the season and

could be classified as flattened, sub-erect, or erect. In the older plants the leaves remained sub-erect or erect in marked contrast to the flattened position often taken by the leaves of younger plants in early spring.

Some alteration in leaf shape during the ageing of plants grown in special conditions are discussed later.

Regeneration following injury.—The regeneration of leaves following the removal of the crowns of plants of different ages was recorded. Three first-year plants, biotypes Z.301, Z.257, Z.282, having deeply lobed leaves (as shown in diagrams 2–4, Figure 2), were used and the crowns removed in July 1937. The new leaves which soon appeared were entire and remained so throughout the winter, affording a strong contrast with the deeply lobed leaves of the undamaged plants of the same strain. In the following spring the three plants with regenerated crowns had lobed leaves, the plants flowered and were indistinguishable from the undamaged plants in their rows. The new rosettes here repeated, though more slowly, the sequence of leaves developed by the seedling. They may be compared with the plants studied by Sears (1922). When the crowns were removed in May 1937 from three four-year-old plants of the apomict Z.145 already described, the new leaves developed in June were slightly and irregularly lobed but were identical with those found at the same time on undamaged plants of the same age. They also followed the same sequence of changes, which was recorded until autumn of the following year.

In a plant of the biotype Z.208 the leaves were eaten and completely destroyed in June, during the second growing season ; the growing point, however, remained. The new leaves produced were all lobed and comparable with those of undamaged plants of this strain.

The plants (ramets) obtained by cloning an old plant showed a definite but slow change in leaf form, from an entire to a dissected type. Plants five to six years old having crowns consisting of a number of rosettes with entire leaves, were divided ; about twelve ramets from each of the two plants used were planted in soil new to dandelions. The apomicts used were Z.145, cloned in September 1937, and Z.73, cloned in November 1937. In the following June the leaves of the ramets were entire and very similar to those of the old plants of the same stock, the largest leaves of ramets of Z.73 were about 12 cm. long. In October the leaves of the ramets had become large, for Z.73, 23 cm. long, and dissected, in contrast to the smaller entire leaves of the old plants. The largest leaves of the old plants of Z.73 in October measured 13 cm. in length. In these experiments some of the rosettes planted had all the old leaves removed, in others they were allowed to remain. Various amounts of the old root were left. The ramets which developed showed no differences corresponding to these different

treatments. Further experiments on the regeneration of plants grown under special conditions in a greenhouse are discussed later.

The influence of food supply.—Two sets of culture experiments carried out with small numbers of plants to test the effect of the supply of the elements nitrogen and calcium, suggest that the fully lobed leaves characteristic of a particular biotype are developed only if these elements are provided. In the first experiments, begun in July 1937, the apomicts Z.145 and Z.73 were used. Seedlings having about three leaves, the largest not more than 8 cm. long, were planted in sand in 7 in. pots which were sunk in the open, exposed to full sunlight. Three plants of each apomict received a culture solution poor in nitrates and the same number received a complete solution containing additional nitrates. Two months later the plants deprived of nitrates had leaves slightly but definitely less dissected than those of the controls.

Further experiments were carried out in September 1938 in the laboratory, using the apomict Z.73. Seedlings were again grown in sand and the pots placed in sunlight. Three plants received a complete culture solution, three a solution poor in calcium, and three a solution without nitrates. Three months later the plants having the complete solution had an average number of 22 leaves,

Fig. 5. Outlines of leaves from plants of the biotype Z.145. Seed planted 28-5-1937 : leaves collected 21-9-1937. 1. Plant grown in sunlight. 2. Plant grownin the shade. Diagrams $\times \frac{1}{2}$.

the eighth or ninth and succeeding ones being lobed ; those receiving a poor supply of calcium had an average of 18 leaves, slightly less lobed. Those without nitrates had only 6 leaves, which were entire. The nitrogen starved plants, obviously retarded in their development, presented a marked contrast with the differently treated plants of the same age ; they may be compared with the plants described below, which were grown in dull light.

The influence of light.—Preliminary experiments with two apomicts Z.145 and Z.73 showed the very marked influence of light on leaf form. Seedlings from the same batch as those used for the first culture experiments were planted in July 1937 in pots using garden soil. Three pots containing plants of the apomict Z.145 and four of Z.73 were sunk in the ground in the open and exposed to full sunlight. The same number of plants in pots were sunk in the ground in a position shaded throughout the day by a large lime tree. As far as possible, all the plants were kept equally moist. Two months later the plants grown in sunlight had flattened rosettes of lobed leaves, the largest formed by Z.73 being 9·5 cm. long ; the plants grown in the shade had sub-erect rosettes the leaves being larger, for Z.73, 15·5 cm. long, and entire. Leaves from plants of the apomict Z.145 are shown in Figure 5.

The total number of leaves produced by plants grown for three months in the sun was considerably greater than that formed by plants of the same age grown for the same time in the shade. The average numbers were approximately, for Z.145, 13 in the sun, 5 in the shade ; for Z.73, 18 in the sun, 7 in the shade. One plant of the apomict Z.73 was in a position reached by sun flecks and it was noticeable that the leaves of this plant were more dissected than those growing in the complete shade.

Experimental work with Plants grown under Special Conditions.

Treatment with growth substances.—In order to test the possibility that the differences in leaf shape might be connected with the supply of growth hormones, plants were grown at Kew in a cool shaded greenhouse where the conditions were such that entire leaves were formed. The seedlings were then treated with the three growth substances α napthaline acetic acid, β indole acetic acid, and β indole butyric acid. Solutions of two concentrations were used, 1 : 20,000 and 1 : 2000. These were prepared by dissolving the weighed quantity of the growth substance in a small amount of methylated spirit, after which the required volume was made up with tap water. About 6 cc. of the solution was sprayed on the leaves of each plant by an atomiser. The growth substances were also applied in lanoline paste prepared by warming 1 gm. of hydrous lanoline until it just melted, when ·05 gms. of the substance were stirred in. The paste was applied when it was cold, to the growing point or youngest leaves of the plant.

In the first experiments only β indole acetic acid solution of the lower concentration was used. Seedlings of the apomict Z.73, which had two or three leaves between 2 and 3 cm. in length, were treated at the beginning of May 1938. Six plants in the greenhouse were sprayed and as controls six untreated plants were grown in the greenhouse. Plants were also grown in pots sunk in the ground in the open in full sunlight and of these, six were sprayed with β indole acetic acid solution and six left as controls. No response to the first application of the growth substance was obtained and the treatment was repeated every fourth day for thirty-two days, but without positive results. In August, treated and untreated plants in the greenhouse had exactly similar entire leaves, 18 cm. long, like those produced by this biotype when grown in the shade in the open in previous experiments. The plants grown in sunlight had more numerous and deeply lobed leaves. The plants sprayed with β indole acetic acid appeared to be somewhat more vigorous than the controls.

In further experiments, seedlings of the apomict Z.145 were treated with solutions of the three growth substances at the higher concentration. Seedlings having three leaves, the largest 6 to 7 cm. long, were selected at the end of June 1938. Six plants grown in the greenhouse were treated with each solution and six untreated plants were grown in the greenhouse and in the open. Twenty-four hours after treatment the leaves of all the plants sprayed were rolled tightly outwards ; five days later they remained only slightly curled. After seventeen days differences were noticeable between the sets of plants, those sprayed with α naphthaline acetic acid had made no apparent growth, those sprayed with β indole acetic acid were growing vigorously, while those treated with β indole butyric acid were less vigorous than the control plants or those which received β indole acetic acid. At the beginning of October the control plants in the greenhouse had six entire leaves, the largest being 23 cm. long. The leaves of all the plants grown in the greenhouse and sprayed with growth substances were of this same shape, the only difference seen between the sets of plants was in the amount of growth made. Of the plants treated with α naphthaline acetic acid, two had died, two were very retarded, having only three leaves, less than one third the size of those of the controls, and two were making fairly good growth. Plants which received β indole acetic acid continued to grow rather more strongly, and those which received β indole butyric acid rather less strongly, than the controls. The plants in the sun had at this time eighteen deeply lobed leaves, the largest 19 cm. long.

Experiments using the same three growth substances in lanoline paste were also begun in June, using the seedlings of the apomict Z.145. Six seedlings were treated with each growth substance. Twenty-four hours after treatment the leaf bases had become bent so that the leaves were flattened instead of in a sub-erect position.

Some flattening persisted for twelve days and the tips of the youngest leaves in contact with the paste did not develop. A second application of paste was made fourteen days after the first. After a further twenty-four hours the application of α naphthaline acetic acid and of β indole acetic acid had caused flattening of the leaves but treatment with β indole butyric acid had no visible effect. In October the plants treated with α naphthaline acetic acid had all died, those treated with β indole acetic acid were indistinguishable from the controls, those treated with β indole butyric acid were similar in growth but less vigorous.

The shape of the leaf produced by the apomicts Z.73 and Z.145 when grown in dull light for seven months is seen to be unaltered by the application of the three growth substances α naphthaline acetic acid, β indole acetic acid and β indole butyric acid, although these substances may affect the general vigour of the plant.

The effect of the growth substances contained in the proprietary product "Auxan," on plants of the strain Z.145 was tested. A five-year old plant was taken in August 1938 and sixteen ramets obtained from it. On the crowns taken, three or four leaves were retained, the largest not more than 6 cm. long. A length of 2–3 cm. of root was left and was cut across diagonally. The roots of eight ramets were dipped in "Auxan" and four planted in the sun and four in pots in a shaded greenhouse. The same number of untreated ramets were planted as controls. All the plants made new growth but no difference between treated and untreated plants was seen at any time during the six months that the experiment was in progress.

An experiment in grafting.—If the difference between the leaves formed by plants of the same biotype grown in the sun and in the shade is connected with the presence of hormones effective only in certain conditions, it is conceivable that such growth substances might pass across the cut surfaces of a graft and influence the new leaves developed from graft or stock. Plants of the apomict Z.73 were used in this experiment. One plant, grown from seed planted in February 1938, in a pot sunk in the ground in the open, had in August developed a crown of characteristic lobed leaves. The pot was then taken to a cool shaded greenhouse and the crown of the plant removed. Two other plants of the same age which had been grown in the shade and had entire leaves were also taken and the crown removed from one of them. From the other, the leaves were removed and the crown cut to the shape of a wedge 1·5 cm. in length. This was used as the graft and inserted in a wedge-shaped incision in the root of the plant grown in the sun. Graft and stock were bound together. The plants were kept in the greenhouse. Four weeks later the plant grown from seed in the shade had developed entire leaves, while the graft had leaves slightly and irregularly lobed. No leaves were at this time developed from the stock, but after a further three weeks slightly lobed leaves were

found. These types are illustrated in Figure 6. The graft did not continue to grow; graft and stock became separated by layers of cork. The result of this experiment, suggesting some influence of stock on graft, needs to be confirmed by a number of further experiments with grafts and must also be interpreted in the light of the experiments on the regeneration of crowns and of the data on the development of leaves, given below.

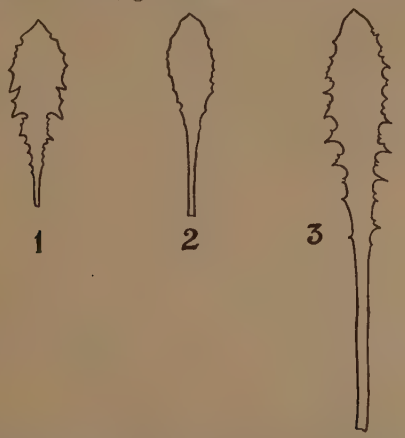

Fig. 6. Outlines of leaves from plants of the biotype Z.73, grafted six months after germination. 1. Leaf from graft taken 4 weeks after grafting. Plant grown in the shade. 2. Leaf growing from cut crown of a plant grown in the shade, 4 weeks after the crown was removed. 3. Leaf from stock taken 7 weeks after the crown was removed and graft made. All diagrams $\times \frac{1}{2}$.

Regeneration following injury.—Four plants of the same apomict, Z.73, as those used in the previous experiment were taken in October 1938. They had been grown from seed planted in the previous March in pots sunk in the ground in the open. The plants had produced deeply lobed leaves. The main roots had grown through the drainage holes of the pots to the soil below and were broken across when the pots were removed. The crowns of the plants were cut off and the pots placed on their sides, three in the shaded greenhouse and one in the open. Dandelions quickly develop numerous buds when the crowns are removed: if a growth substance influencing growth shape were present and this diffused downwards, the buds developed at different levels might show the influence of the hormone in varying degrees.

Seven weeks after the crowns were removed new leaves had developed at the anterior ends of all the plants. Also in two of the plants grown in the greenhouse callus had formed at the distal ends of the cut roots and in one of them leaves were also produced from this end. Three months later the plants presented a very varied appearance: that in the open had broad dissected leaves, and of the plants in the greenhouse one had entire leaves and one having five

buds had only entire leaves developed from three of them, but slightly lobed leaves were formed from the two lower buds. In the latter plant lobed and entire leaves were, three weeks later, found in the same bud. The remaining plant continued to develop leaves at each end of the root. These are shown in plate 1, fig. 1, taken in February 1939, twenty weeks after the crown of the plant was removed. Nine leaves were developed from the distal end : these were definitely lobed, dark green in colour and had hairs scattered over midrib and blade. The fifteen leaves formed at the anterior end were, with the exception of two slightly lobed leaves produced from buds at the lowest level, entire ; they were lighter in colour and hairs were less numerous. The leaves at each end of this plant had been exposed to similar external conditions, although the rim of the pot would possibly have caused additional shading during the early stages of development of the leaves at the anterior end.

Variation with age of plants grown in the shade.—The plants treated with growth substances in May and June 1938 were, with the control plants, grown in the shaded greenhouse for a further twelve months. For several months only entire leaves were developed in contrast to the deeply lobed leaves produced by plants of the same stock and age grown in full sunlight. Later, the shaded plants showed a sequence of leaf-forms irrespective of their treatment with growth substances but depending on the age of the plant from seed and it appears that the effect of shading is to retard rather than to inhibit completely, the production of lobed leaves by biotypes normally producing them. Plants of the apomict Z.73 grown from seed planted in February 1938 had at the end of October developed lobed leaves ; plants of the same strain grown in the same conditions from seed planted in November 1937, formed slightly lobed leaves in the following May and distinctly lobed ones in August. Plants of the apomict Z.145 behaved similarly ; those grown from seed planted in June formed lobed leaves at the end of November. The lobed leaves formed in these conditions were characteristic for the biotype but distinct from those developed in full sunlight. They are illustrated for Z.73, in Figure 7. In these experiments the shading of the greenhouse was not absolutely complete, sunlight penetrated for a short time in the early mornings during July and October.

The influence of moisture.—Seedlings of the apomict Z.73 planted in pots in April, were grown in the greenhouse as in the previous experiments. Four plants were given only sufficient water to prevent wilting ; four similar plants, watered freely, were covered by a bell jar. Control plants were given a liberal amount of water but were left uncovered. In August the leaves of all the plants were entire, but there were some differences in their proportions : the leaves of plants kept dry were shorter (maximum length 16·5 cm.) and those of the plants grown in a moist atmosphere were longer (maximum length 21·5 cm.) than those of the controls, the maximum

Fig. 1. Plant of the biotype Z.73, showing leaves formed from buds developed after the crown was removed and the root cut across; original crown on left.
Photo. taken 27.2.39. × ⅓.

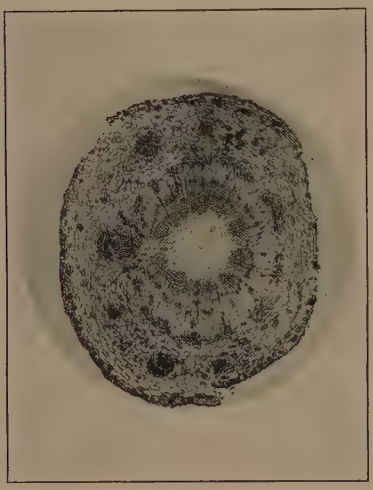

Fig. 2. Transverse section of young vertical rhizome. ×17.

Fig. 3. Transverse section of the crown of a plant before the elongation of the inflorescence axis. ×47.

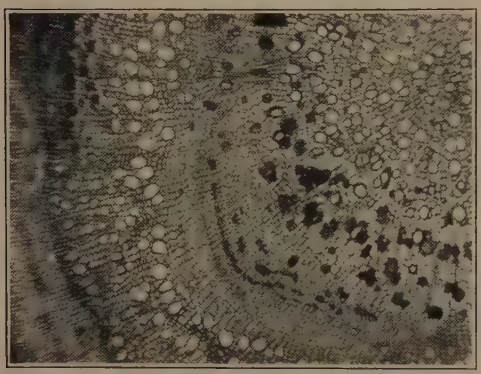

Fig. 4. Transverse section of root showing secondary cambium. ×41.

[*To face page* 12

length of which was 19 cm. In September, lobed leaves were formed by the plants kept dry and in December three of these plants had only lobed leaves. The crown of the fourth plant had divided, although no inflorescence axes could be seen, and the two rosettes had entire leaves. The new rosettes, as in the plants described by Sears (1922), developed a leaf shape characteristic of young plants. The three plants with lobed leaves contrasted strongly with those kept very moist; in these only entire leaves were found. Drought was seen to increase the dissection of the leaves when the dry conditions obtained for several months.

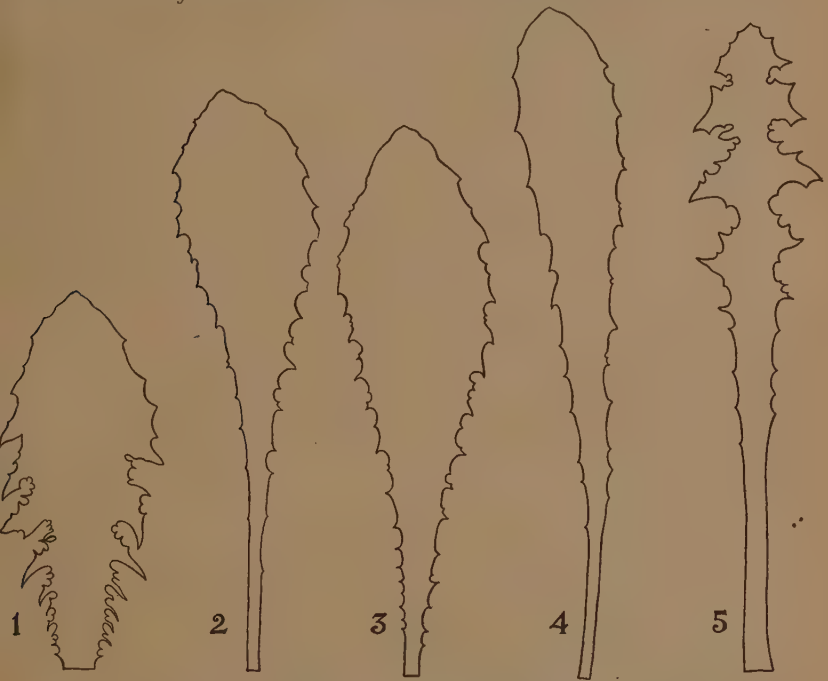

Fig. 7. Outlines of leaves from plants of the biotype Z.73 grown in different conditions. Diagrams 1–4, leaves from seed planted February 2nd, 1938. Diagram 5, leaves from seed planted November 15th, 1937.
1. Plant grown in the open in sunlight. 2. Plant grown in unheated greenhouse, shaded. 3. Plant grown in unheated greenhouse, shaded, kept dry. 4. Plant grown in unheated greenhouse, shaded, kept very moist. 5. Plant grown in unheated greenhouse, shaded. All diagrams $\times \frac{1}{2}$.

Pearsall & Hanby (1926), in a study of the modifications of the leaf as laid down in the bud and the development of its final form in some woody Dicotyledons, have shown that leaf growth is affected by hydrostatic pressures, being increased by positive pressures and restricted by negative ones. They found that the seasonal variations in leaves such as those of sycamore could be explained by the

variation in internal hydrostatic pressure. Sycamore leaves were more dissected in the summer when conditions were such that a negative pressure was produced. Griffiths (1924) referring to a preliminary account by Pearsall & Priestley, on factors affecting leaf form, suggested that the leaf of *Taraxacum* might be particularly sensitive to changes in water pressure, a low water pressure being associated with dissected leaves.

Development and Structure of the Leaves.

The foliage leaves are arranged to form the characteristic rosette at the surface of the ground, the internodes of the stem remaining very short. The phyllotaxis is commonly $\frac{3}{8}$ but, as in other rosette and semi-rosette hemi-cryptophytes such as *Crassula orbicularis* described by Raunkiaer (1934), the vertical members of a series sometimes show a slight divergence from strictly superimposed rows.

The persistence of the leaves varies with the biotype and with the season. At the end of August 1936, actively growing leaves of the biotypes Z.193, Z.196, and Z.208 were marked when they were 6–8 cm. long. Fourteen days later the leaves had reached their full size for the season, in Z.193, 16·5 cm., in Z.196, 12 cm., in Z.208, 9 cm.; they were withering thirty days after they were first marked.

The total number of leaves developed by a plant of a particular biotype in a certain time was found to depend on the environmental conditions. Figures have been given to show the larger number of leaves developed by plants given a complete culture solution in comparison with the number formed by nitrogen starved plants in the same time. Preliminary experiments to compare plants grown in the sun and in the shade showed that the plant grown in the sun formed the larger number. In a further experiment of this kind, seed of the apomict Z.73 was planted in February 1938. A plant grown in the sun had in November 1938 developed more than 100 lobed leaves, vigorous flowering had taken place in October and the crown had become divided into a number of rosettes. A plant of the same age grown in the shade had in November produced only 19 entire leaves. Development in these apomicts was therefore much more rapid in the sun than in the shade.

The lobed leaves characteristic of a particular biotype are laid down at a very early stage in the development of the rosette. The smallest leaves, 0·56 mm. in length, that could be dissected from the growing points of plants of the apomict Z.73 grown in the sun for five months, showed clearly the four lobes characteristic of the mature leaf. The material examined was cleared in lactic phenol and in the leaves 0·56 mm. long, vascular tissue was found to be indicated only by elongated cells in the position of the midrib. The ratio of the width of the leaf across the sinus to that across the lobe, measured at right angles to the midrib, varied from 1 : 1·3, to 1 : 1·9, in five leaves measuring between 0·56 mm. and 2 mm. in

TABLE I.

Number of Cells in Sections taken across Sinus. Width of Blade, 3·65 *mm.*

Number of cells in Upper Epidermis*	Number of Stomata	Number of cells in palisade	Number of air spaces of width greater than 1 palisade cell.
154	9	198	8
160	8	180	8
161	5	177	8
153	7	199	6
156	5	193	10
152	8	179	9
159	6	181	7
161	7	186	8
163	7	191	7
156	9	192	8

Average number of epidermal cells per mm. (stoma counted as 1 cell), 45.

Average number of palisade cells per mm. (1 air space counted as 1·5 cells), 52.

TABLE II.

Number of Cells in Sections taken across Lobe. Width of Blade, 5·55 mm.

Number of cells in Upper Epidermis	Number of Stomata	Number of cells in palisade.	Number of air spaces of width greater than 1 palisade cell
238	15	268	18
239	11	286	10
249	12	280	8
226	13	256	12
235	11	275	12
240	12	270	15
242	12	278	10
238	11	269	13
241	10	272	12
236	11	279	13

Average number of epidermal cells per mm. (calculated as above), 45.

Average number of palisade cells per mm. (calculated as above), 53.

* Actual counts of " cells " as seen in transverse sections. Possibly the actual number of cells is somewhat lower owing to irregularity in contours and the counting of lobes as cells. The same remark applies to the next table. The figures in the two tables should, however, be considered comparable in general terms.

length. The proportions were 1 : 1·8, to 1 : 2·3, in five leaves measuring between 9 cm. and 11·5 cm. in length.

The later development of the young leaves in the bud, involving the maintenance of the degree of dissection seen at early stages and some increase in it, would appear to be brought about by cell division rather than by alteration in the size of the cells laid down. This is shown by the data in Tables I and II giving details of the numbers of cells seen in transverse sections of a leaf collected in September 1939 from a plant Z.73/F grown in the sun for six months. Serial sections of the leaf were cut at a thickness of 15μ and the number of cells in the upper epidermis and in the adjoining palisade layer were counted.

An attempt to correlate the form of the mature leaf with the time of development of the primordium in the bud showed that in plants of the biotype Z.291, the leaves developed at the time of flowering in May were probably present in the bud in February. The plants studied were grown in the ground in the open and collected during their second growing season, the crown of each plant selected having divided into three rosettes. The dissected leaf characteristic of this biotype at the time of flowering is shown in diagram 5, Figure 2. The number of leaves and of inflorescence axes developed and the number that could be dissected from the buds was determined in February, before active growth began and in May, after the plants had flowered. The data for these plants are given in the following table :

TABLE III.

Number of Leaves and Inflorescence Axes developed by Plants of the Biotype Z.291.

	Plant collected 7/2/1939			Plant collected 14/5/1939		
	Number of leaves developed	Number of leaves dissected from growing point	Number of inflorescence axes	Number of leaves developed	Number of leaves dissected from growing point	Number of inflorescence axes
Crown I	21	24	9	23	2	8
Crown II	9	22	11	28	2	12
Crown III	8	25	16	32	3	15
Totals for 3 crowns	38 +	71	36	83 +	7	35

Although data of the persistence of the leaves of this biotype have not been obtained, comparison with plants of the biotypes Z.193,

Z.196, Z.208, previously described, suggests that the leaves persist for only a few weeks after they are mature. Leaves of the biotype Z.291, functional in the autumn, would then develop from primordia not visible until after flowering.

A study of the vein islets in leaves, that is the areas enclosed by the smallest veins, has been suggested as a criterion of senescence : Bijhouwer (1931) has drawn attention to the literature on this subject. For *Taraxacum*, Sears (1922) found that the changes in leaf shape were independent of the number of vein islets per unit area of leaf. The present work on certain biotypes of *Taraxacum* confirms the lack of correlation between leaf shape and the number of vein islets per unit area. The areas of leaf examined were taken from the middle of the blade in the region between midrib and margin, they were decolourised and cleared in lactic phenol to which a little cotton blue had been added. The numbers of vein islets and of free vein endings in twelve such areas each of 1 sq. mm. were counted and the average taken. The appearance of the vein islets in a mature leaf of the plant Z.193/D is shown in Figure 8.

Fig. 8. Vein islets in a leaf of the plant Z.193/D. Area shown = 1·5 sq. mm.

Mature leaves from plants of eight biotypes grown in similar conditions were examined. The number of vein islets per sq. mm. did not prove to be characteristic for a biotype and a high degree of variation was found in the mature leaves of one plant. No significant difference in number was shown by the entire and dissected leaves formed by one plant at different ages. If the shape of these leaves is connected with the pressure of water supply a difference might be expected, since Pearsall & Hanby (1926) found that an increase in hydrostatic pressure resulted in an increase in the number of veins and the formation of smaller vein islets. Some difference was found in leaves of plants of the same age taken from each of two stocks grown in the sun and in the shade. The differences, however, were of the same order as those previously obtained in one plant. Details of the numbers of vein islets per sq. mm. of leaf are given in Table IV.

An examination of the larger veins in *Taraxacum* leaves showed that in many entire leaves the lateral veins diverged from the midrib making an obtuse angle towards the base of the leaf. In lobed leaves the lateral veins either diverged approximately at

TABLE IV.

Number of Vein Islets per sq. mm. of Leaf Blade.

Plant	Type of leaf	Date collected	Number of islets per sq. mm.			Number of vein endings per sq. mm.		
			Average of 12 areas	Maximum	Minimum	Average of 12 areas	Minimum	Maximum
Z.179/B ...	Dissected	8/5/36	16·1	20	9	3	6	0
Z.193/D ...	,,	,,	14·9	22	11	4·9	9	0
Z.199/E ...	,,	,,	16·1	26·5	8	1·9	6	0
Z.194/E ...	,,	,,	8·2	10	6	3	7	1
Z.196/C ...	,,	,,	11·9	14	9	1·5	3	0
Z.200/E ...	,,	,,	11·7	16	9·5	6·4	10	1
Z.208/C ...	,,	,,	16·9	28	11	1·4	4	0
Z.208/A ...	Entire	25/10/35	6·5	9	4·5	2	4	1
Z.208/A ...	Dissected	,,	8·8	14	5	1	4	0
Z.145/D ...	,,	8/5/36	14·4	23	12	3	5	1
,, ...	Entire	25/10/35	12·6	19	6·5	5·8	14	2
,, ...	,,	,,	4·9	7	1·5	4·2	4	1
,, ...	,,	,,	9·9	13	7	3·2	8	0
,, ...	Entire young	,,	12·1	18	9	1·6	5	0
Z.145/sun ...	Dissected	21/9/37	14·6	19	9	3·1	7	0
Z.145/shade ...	Entire	,,	4·7	7	4	3·9	4	2
Z.73/sun ...	Dissected	10/8/38	11·1	13·5	9	5·2	12	1
Z.73/shade ...	Entire	,,	6·3	8·5	4	5	7	3

right angles to the midrib or the angle of divergence was similar to that found in the entire leaves, but the lateral veins bent sharply, often at right angles, to supply the lobe. It was not possible, however, to obtain a strict correlation between the degree of lobing and the path of the lateral veins.

In transverse section, the blade of a mature leaf taken from a plant grown in the sun showed two rows of palisade cells which were only slightly elongated in a direction at right angles to the blade. Four to six rows of rounded cells made up the mesophyll. Air spaces were numerous throughout. Stomata occurred in both upper and lower epidermis and were raised a little above the surface. The entire leaves characteristic of a plant grown in the shade were thinner than the lobed ones formed by a plant of the same age growing in sunlight. Often in the " shade " leaves only one clearly defined layer of palisade cells was found and fewer layers of spongy parenchyma. Transverse sections of " sun " and " shade " leaves are shown in Figure 9. No significant anatomical differences were noticed between the lobed leaves and the non-dissected ones found at a later stage in the life of the plant. All of the older leaves of plants that were examined in the summer and autumn were infected by the fungus *Puccinia Taraxaci*. A characteristic feature of all leaves collected after exposure to conditions suitable for photosynthesis, was the occurrence of oil drops in the cells : generally one large drop was found in every cell of the mesophyll.

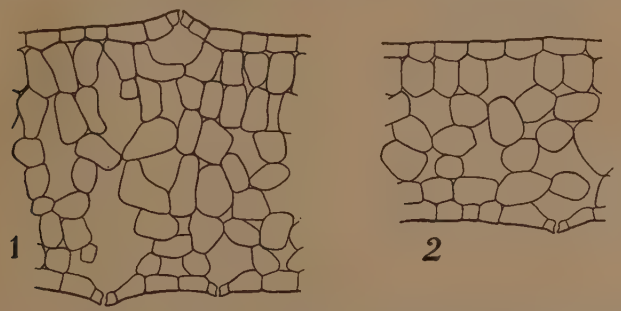

Fig. 9. Transverse sections of leaves of plants of the biotype Z.73, collected 22-9-38. 1. Plant grown in the sun. 2. Plant grown in the shade. Diagrams × 240.

Root Structure.

The young roots examined had a diarch structure. The central relatively small mass of xylem was composed of tracheids and vessels having close annular, spiral or scalariform thickenings. Pitted vessels were not found. Medullary rays were prominent. In older roots, which have been described by DeBary (1884), the bulk of the fleshy part was made up of secondary phloem consisting of parenchyma, sieve tubes and articulated laticiferous vessels. The occurrence of sieve tubes is of interest : Jeffrey (1917) recorded this

fact, but denied that the development of the milk system is in inverse proportion to that of the sieve tubes; he found that in the root of *Taraxacum* sieve tubes could not be clearly distinguished from laticiferous vessels. In the material now studied sieve tubes occurred abundantly although they could not be identified with certainty in stained sections and special methods were necessary for their isolation. The sieve tubes were isolated in sections macerated in acid alcohol for twenty-four hours (one part of hydrochloric acid to four parts of alcohol) and subsequently treated with 10 per cent. ammonia. In sections of old roots collected in the autumn the callose on the sieve plates could be stained with corallin soda, with Russow's callus reagent or with aniline blue. In transverse sections of the roots, sieve tubes and laticiferous vessels occurred in groups arranged in concentric circles in the parenchyma. The parenchyma cells formed regular radial and vertical rows with air spaces between them. The narrow sieve tubes were approximately the same length as the parenchyma cells, and sieve plates which were transverse or nearly so, occurred on the end walls at the level of the transverse air spaces in the parenchyma. At this level also, anastomoses between the laticiferous vessels were most frequent, hence the sieve plates were easily overlooked unless special methods were used to demonstrate their presence. Sieve tubes, laticiferous vessels, and the parenchyma of the secondary phloem are shown in diagrams 1 and 2, Figure 10.

In the cortex of the root and of the stem, structures superficially resembling laticiferous vessels were found. The tangential walls of a small group of parenchyma cells had thickened, partly broken down and separated so that an intercellular space was formed such as is illustrated in diagram 3, Figure 10. The space so formed sometimes contained a secretion. These cavities are similar to the "pseudo-canals" noted by Col (1903) in other *Liguliflorae*.

Secondary thickening in the root resulted mainly in the addition of phloem, only a little xylem was added. Cork cambia, first formed in the outer layers of the cortex and later in the phloem, prevented any considerable or regular increase in the diameter of the root. It was not found possible to determine the age of a plant by counting the "annual rings," as suggested by Roberts (1936).

Stem Structure.

The region which could be identified anatomically as stem in a normally grown plant, was very short, a length of less than 1 cm. below the growing point of the crown. The upper part of the stem bearing the closely packed leaves of the rosette had a structure complicated by the crowded and overlapping leaf bases. This short stem may be compared with the long vertical underground stems which were sometimes found to develop from buds which arose adventitiously on pieces of the roots of old plants when such roots had been broken across and were left or had become buried in the

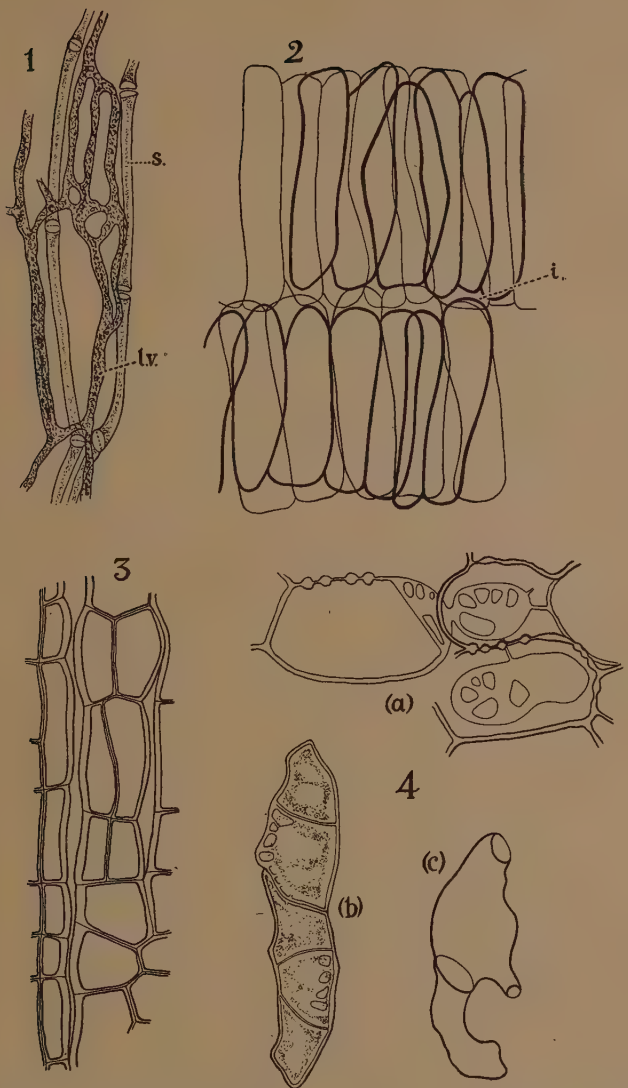

Fig. 10. 1. L.S. root, macerated to separate sieve tubes. s=sieve tubes; l.v.=laticiferous vessel. 2. L.S. root, parenchyma of secondary phloem. i=intercellular space. 3. L.S. root, "pseudo-canals" in cortex. 4. (a), T.S. apex of crown, pitted parenchyma cells of pith. (b), (c), apex of crown, macerated to separate the cells of the pith. All diagrams × 240.

soil at a depth of 12–20 cm., the rest of the plant having been removed. When roots with secondary phloem were cut across and kept moist, wide V-shaped longitudinal splits were often formed, extending inwards. The uninjured cells were rapidly protected by cork. In the broken roots described, at the anterior ends and at places where splits extended to the central xylem cylinder, callus formed and bore buds from which long stems grew up towards the surface of the soil. The stems, which were twisted, bore scale leaves. The internodes were 2–3 cm. in length at the lower end but shorter at the upper end, while at the surface of the soil a typical rosette of leaves developed. The scale leaves had sheathing bases which completely or nearly encircled the stem, the line of attachment being horizontal or oblique. It was possible to trace the fusion of the decurrent leaf base with the stem through at least one internode. The free portion of the scale leaf was pointed in shape and readily withered from the tip. The whole of the blade sometimes disappeared and the decay spread downwards along the part of the base fused with the stem. Branches arose from buds in the axils of some of the scale leaves; they were often very numerous near the ground level. They emerged making almost a right angle with the main stem and bent to grow up nearly parallel with it.

In transverse section an elongated vertical underground stem showed the familiar Dicotyledonous stem structure, a ring of collateral vascular bundles separated by prominent medullary rays; this is seen in plate I, fig. 2. Each vascular bundle of the stem had a number of well developed laticiferous vessels on the outer margin of the protophloem, representing the pericyclic laticiferous system described by Solereder (1908). Leaf gaps occurred in the ring of bundles. Leaf traces, collateral and concentric bundles and isolated groups of phloem and laticiferous vessels were found in the cortex. As secondary phloem was developed, groups of sieve tubes and laticiferous vessels were formed as in the secondary phloem of the root.

The upper, stem portion of the crown showed the same arrangement of tissues, leaf traces being more numerous in the cortex. Longitudinal sections of the crown showed very clearly the anastomoses between the laticiferous vessels of the protophloem, secondary phloem, and leaf traces.

As cork formed readily in the secondary phloem, outer structures were soon removed, but a careful study of the underground stem, the developing crown and the hypocotyl of the seedling (shown in diagram 2, Figure 11) strongly suggests that in accordance with the leaf skin theory of Saunders (1922), the external tissues of these organs are formed by the leaf bases which are decurrent and fused with the outer layers of the stem.

Near the apex of the stem the pith consisted of a characteristic spongy tissue. The cells had thick cellulose walls: the tangential

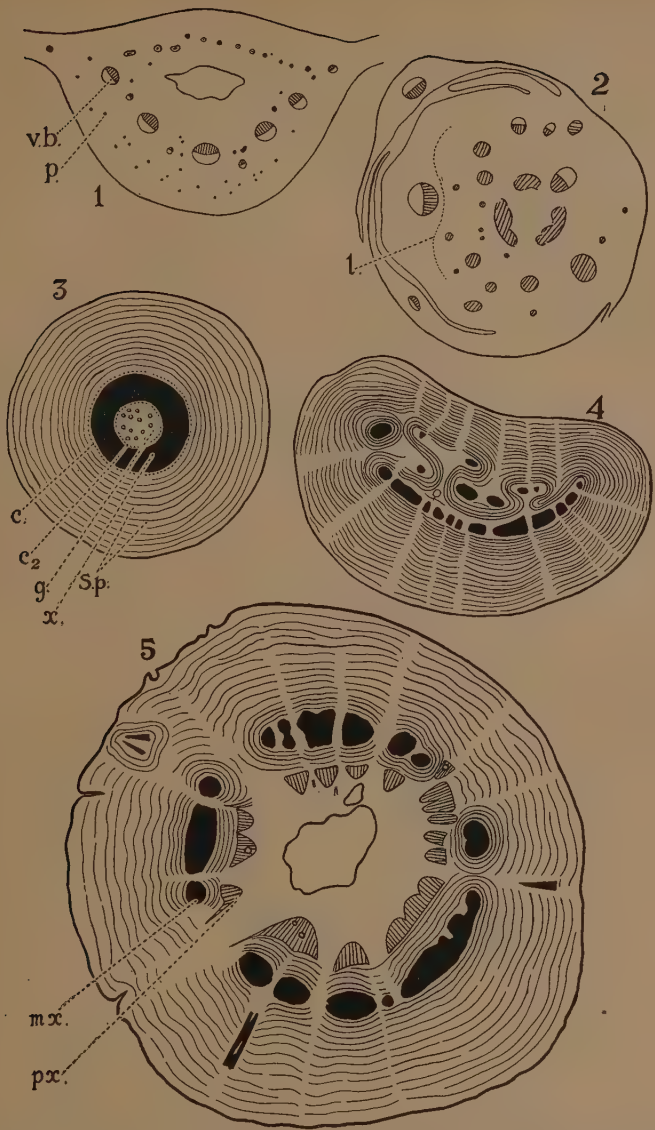

Fig. 11. 1. T.S. leaf base, ×13. v.b.=vascular bundle. p.=groups of phloen and laticiferous vessels. 2. T.S. hypocotyl of seedling, ×33. 1=line of future separation between leaf and stem. 3. T.S. root, ×8. c=cambium; c_2=secondary cambium; g=deposits of gum in xylem; s.p.=groups of sieve tubes and laticiferous vessels in the secondary phloem; x=functional xylem. 4. T.S. "branch" formed by longitudinal splitting of the crown, ×2. 5. T.S. base of crown in an old plant, ×4. px.=protoxylem of original bundles; mx.=metaxylem.

walls were especially thick and tended to separate so that concentric circles a few cells in depth, resulted. The cells were often irregular in shape, sometimes with outgrowths pushing into the intercellular spaces. Between some of the adjoining cells the end walls had broken down or were perforated by large simple pits so that an irregular series of canals was formed. Some cells from this tissue are shown in diagram 4, Figure 10. It is in this spongy pith that changes were found preceding the division of the crown.

Division of the Crown.

In each of some fifty plants examined, the terminal bud of the stem formed an inflorescence. In six specimens, before the elongation of the inflorescence axis, the central cells in the spongy pith of the crown had broken down and the cavity was isolated by a cork cambium. A secondary cambium was also found in the pith adjoining the protoxylem. This structure is illustrated in plate I, fig. 3. Sections taken at a lower level showed this cambium as a continuous ring. In some twenty specimens of the same age, deposits which were golden brown or crimson in colour were found in the pith of the crown : they occurred when there was no external evidence of injury. The deposits gave the reactions characteristic of a gum : when heated with hydrochloric acid, a trace of orcin added, and the substance again heated, subsequent addition of ferric chloride gave a dark green colour. Cells containing the gum were isolated by meristematic cells, and as in the specimens already described, two concentric cylinders of cambium were found. The inner, secondary cambium cut off a small amount of xylem on the side adjoining the original xylem, and towards the inside of the stem, a large amount of secondary phloem. The secondary cambium was seen in sections taken at a lower level to join the original one at several points, thus isolating a number of separate xylem masses. By the continued activity of the cambia a number of secondary steles were formed. This is seen in diagram 5, Figure 11. Cork cambia developed in the secondary phloem led to the complete isolation and separation of the secondary steles through a certain length of the stem and root.

In those plants where no break-down of the pith or deposits of gum were found before the time of flowering, branching of the crown appeared to follow the decay of the terminal inflorescence axis. The decay at the base of the axis spread downward, affecting some of the central cells of the pith of the stem and central vessels of the root, sometimes for a considerable distance. Branching initiated by the decay of the terminal inflorescence axis has been described by Fritsché (1914) for *Taraxacum*. In this method of branching the decayed tissue was isolated by cork and secondary cambia formed within the xylem cylinder as in the plants described above.

In all plants in which they were formed, the activity of the secondary cambia in the isolation of separate steles led to the

production of a number of apparently short " branches " terminating in new rosettes and arising from the main root. A study of the development of these " branches " showed that they originated by a splitting which extended downwards from the apex of the stem. In structure the " branches " closely resembled roots unless only two or three were developed when the steles were flattened in transverse section. This is shown in diagram 4, Figure 11, which also illustrates the irregular course of the cambium frequently seen.

In plants six to seven years old, a high degree of separation of the roots was reached and it was sometimes found that the divisions of the root corresponded to the number of new crowns developed. Such crowns had strands of vascular tissue which could be traced a considerable distance along the root and even throughout its length. Not infrequently in these plants some crowns separated completely and grew as new individuals. In other plants, divisions of the root were complicated by the formation of cambia which isolated deposits of gum. Such cambia are seen in the transverse sections of roots shown in plate I, fig. 4, and in diagram 3, Figure 11. The cambia often took very irregular lines leading to numerous irregular divisions. Separation might be complete for only a short distance and the plant then seemed to show " branch roots " fusing at a lower level with the root of their origin. Further, a true fusion of roots was also observed, which took place in a way similar to that described by Millner (1932) in *Hedera Helix*.

Concluding Remarks.

A number of biotypes of *Taraxacum* which are morphologically distinct show a considerable plasticity in habit and leaf form, being influenced by factors affected by age, the supply of food, light and moisture. The effect of age was seen in the succession of leaves developed by biotypes grown from seed in the open. In two apomicts the three or four entire leaves produced by the seedling in spring were succeeded by deeply lobed leaves which were formed throughout the year. During the second growing season these plants, like those of three other biotypes, showed a succession of leaf forms : the lobed leaves found in early spring were replaced by a non-dissected type after flowering, while in the autumn a lobed leaf again appeared. In three other biotypes a slightly different sequence obtained, the autumn leaves remained entire. During the third and fourth growing seasons, in six biotypes the leaf pattern of the second year was repeated, although in the older plants the leaves were less regularly lobed and they were carried in an erect or sub-erect position in contrast to the flattened position often taken by the leaves of younger plants. The leaves developed following the complete removal of the crown showed a similar but slower sequence of forms. The same slow sequence was found in the ramets obtained by cloning an old plant.

Ramets grown from small pieces of root and having only a limited food supply developed leaves indistinguishable from those

of well nourished plants. Experiments with culture solutions suggest that the elements nitrogen and possibly calcium are necessary for the development of the lobed leaves characteristic of a particular biotype.

Light was shown to influence leaf form and the number of leaves developed by a plant very considerably. For two apomicts, plants grown in the shade for six to eight months formed only a small number of entire leaves, while plants of the same age grown in the sun developed a much larger number of deeply lobed leaves. The shade plants later formed leaves showing some degree of dissection : the sequence characteristic for sun plants of these apomicts is seen to be delayed and modified in shade conditions.

Water supply also affects leaf shape. In an apomict having normally a lobed leaf, plants grown in the shade but kept dry formed shorter more dissected leaves than the control plants. Growth in the shade and a saturated atmosphere for twelve months resulted in the formation of only entire leaves.

Experiments designed to test the influence of growth hormones showed that the substances α naphthaline acetic acid, β indole acetic acid and β indole butyric acid, when sprayed by an atomiser over the young leaves of seedlings or applied in lanoline paste to the growing points, did not affect leaf form, although they affected the general vigour of the plant. An attempt to detect a growth substance by a chemical colour test in extracts of plants produced negative results.

A study of the development of the leaves showed that the lobed leaf characteristic of a particular biotype is laid down at an early stage in the development of the rosette. The further growth of the young leaf at the lobes is accompanied by cell division : measurements of epidermal and palisade cells at sinus and lobe showed that the cells were of the same dimensions in these two regions.

The vein islets of the leaves were examined. The number of islets in a unit area of leaf blade was found to be very variable in any one biotype and the number was not correlated with the leaf shape.

Anatomically the leaf structure is that of a typical dorsiventral leaf. Leaves from plants grown in the sun had two rows of palisade cells, sometimes irregularly arranged and only slightly elongated in a direction at right angles to the blade. The stomata on both upper and lower epidermis were slightly raised. Oil drops collected in the cells of the mesophyll when the leaf was exposed to conditions favourable for photosynthesis. No significant anatomical differences were found in the lobed and entire leaves.

The root develops a relatively small central xylem cylinder and a large amount of secondary phloem. In the latter, consisting of parenchyma and groups of laticiferous vessels and sieve tubes arranged regularly in concentric circles, the numerous narrow sieve tubes were most readily distinguished by maceration or in sections of material collected in the autumn when callose was deposited on the sieve plates of the end walls.

The stem in normally grown plants is very short : long vertical underground stems may be formed from adventitious buds when roots are left deeply buried in the ground. The anatomical structure of these stems was that of a typical Dicotyledonous plant. Laticiferous vessels occurred at the periphery of the protophloem and in the secondary phloem in close proximity to the narrow sieve tubes. The structure of the stem immediately below the crown was complicated by the large overlapping leaf bases.

Division of the crown is connected with the development of cambium within the xylem cylinder. The arcs of secondary cambium rejoined the original cambium at a lower level in the crown, thus causing the isolation of separate xylem masses. This sometimes occurred before the elongation of the terminal inflorescence axis and in such plants there was degeneration of the spongy pith at the apex of the crown or there were found to be deposits of gum in the pith or in some of the first-formed xylem vessels. In other plants, division of the crown followed the decay of the inflorescence axis : the decayed tissue at the apex of the stem was isolated by cork and secondary cambia developed as before. The development of such secondary cambia led to the isolation of secondary steles and these became completely separated by the formation of cork in the secondary phloem. The separation was sometimes complete throughout the plant : in many plants, however, division was only partial and was complicated by the formation of cambia in relation to deposits of gum.

APPENDIX

ORIGIN OF MATERIAL OF BIOTYPES USED IN THE PRESENT PAPER.

Z.73.—Grown from seed collected near Stromness War Memorial, Stromness, Mainland, Orkney, 10.10.1931, Col. H. H. Johnston. The material used was grown from seed from one flowering head of one plant of the original row of plants grown at Kew. This head in the young condition had the corollas and stamens removed by a transverse razor cut before the capitulum opened. The seeds set apomictically and the plants raised were uniform at all stages of development when grown under the same conditions. All the plants used in this paper and quoted under Z.73 were therefore proved apomicts.

Z.145.—Original plant collected on Potterne Fields, Potterne, Wiltshire, 26.1.1932, E. M. Marsden-Jones and W. B. Turrill. The material used was grown from seed from one head of the original plant transplanted to Kew. All the plants were obtained apomictically in the same way as for Z.73.

Z.179.—Grown from seed of one capitulum collected near Ible, Derbyshire, 8.8.1933, W. B. Turrill.

Z.190.—Grown from seed collected on Athos Peninsula, Greece, near Chilandari, 22.4.1934, W. B. Turrill.

Z.191.—Grown from seed collected on Athos Peninsula, Greece, between Kapsokalivia and Lavra, 19.4.1934, W. B. Turrill.

Z.193.—Grown from seed collected on Athos Peninsula, Greece, above Zographu Arsenal, 16.4.1934, W. B. Turrill.

Z.194.—Grown from seed collected on Athos Peninsula, Greece, near Vatopedion, 21.4.1934, W. B. Turrill.

Z.196.—Grown from seed collected on Athos Peninsula, Greece, between Simopetra and Karyes, 13.4.1934, W. B. Turrill.

Z.199. Grown from seed collected by Xerxes Canal, at the north-west end of Athos Peninsula, Greece, 17.4.1934, W. B. Turrill.

Z.200.—Grown from seed collected on Athos Peninsula, Greece, near Stavronikita, 21.4.1934, W. B. Turrill.

Z.208.—Grown from seed collected from one capitulum, north of Aberdeen, on more or less stabilized sand-dunes, 7.9.1934, W. B. Turrill.

Z.224.—Grown from seed collected on Pepeljak, North Macedonia, 10.6.1935, Mrs. H. P. Thompson.

Z.257.—Grown from seed collected by the Pjorsa river, Holt, South Iceland, 22.6.1936, J. C. W. Greene.

Z.282.—Grown from seed collected at Kineton Thorns, east Gloucestershire, 25.5.36, E. Milne-Redhead.

Z.291.—Grown from seed collected on Chailey Common, Sussex, in a damp place in heathland verging towards grassland, 17.5.36, E. Milne-Redhead.

Z.301.—Grown from seed collected near Loch Ine, west Cork, Ireland, 14.8.1936, W. B. Turrill.

Specimens of all the above are preserved in the Herbarium, Royal Botanic Gardens, Kew.

Z.73 and Z.145 are apomicts of the section *Vulgaria*. Z.179, Z.208, Z.224, Z.257, and Z.301 are biotypes, and probably also apomicts, of the section *Vulgaria*. Z. 291 is a biotype of the section *Spectabilia*. Z.190, Z.191, Z.194, Z.196, and Z.200 are biotypes of *T. Hoppeanum* Griseb. et Schenk. Z.193 and Z.199 are biotypes of *T. megalorrhizon* (Forsk.) Hand-Mazz. Z.282 is a biotype of *T. laevigatum* (Willd.) DC.

Acknowledgments.

I should like to express my sincere thanks to Dr. Turrill for suggesting the problem and for his continued help during the research; and to Dr. Metcalfe for his help and the facilities that he has given me in the Jodrell Laboratory.

I should also like to thank Mr. G. Atkinson for photograph 1 and Mr. G. Robinson for photographs 2, 3 and 4, Plate I.

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II—NOTES ON FERNS AND FERN ALLIES: II.

F. Ballard.

Adiantum Lüddemannianum *Moore* in The Florist, 1876, 93 (not Veitch Cat. 1878 as stated in C. Chr. Ind. Fil). A plant of garden origin, it is said to have arisen spontaneously in a French nursery. Its relationships are obscure. Originally stated to be a hybrid between *A. cuneatum* L. & F. and *A. Moritzianum* Link, it was considered a variety of *A. cuneatum* by Schneider and of *A. Capillus-Veneris* L. by Moore. The freakish appearance of the plant with its crispate-tasselled fronds suggests that it is a sport of a kind familiar enough in some other genera, though uncommon in *Adiantum.* It was first described by Carrière as *A. cristatum* in Rev. Hort. **46,**

228 (1874). Although bearing sori the plant is apparently quite sterile.

Adiantum patens *Willd.* var. **Oatesii** (*Bak.*) *Ballard*, stat. nov. *A. Oatesii* Bak. in Oates, Matabeleland, App. V, 369, c. ic. (1881). This plant resembles the tropical American *A. patens* closely and is distinguished only by the soft thin texture and pale green colour of its fronds. Baker believed it to be related to *A. pedatum* L. and this is understandable in view of the sterile incomplete frond that constitutes the type material. The variety has been found in the Bauchi Plateau of Northern Nigeria, Southern Tanganyika Territory, and north western and southern Rhodesia. In Northern Rhodesia the plant grows sometimes on termite hills.

Arthropteris orientalis (*Gmel.*) *O. Posth.* var. **punctulata** (*Bak.*) *Ballard*, comb. nov. *Nephrodium punctulatum* Bak. Syn. Fil. 261 (1867). *Dryopteris orientalis* (Gmel.) C. Chr. var. *punctulata* (Bak.) C. Chr. This is a well-marked variety confined to the Cameroons.

Botrychium lanuginosum *Wall. ex Hook. & Grev.* The name *Botrychium lanuginosum* first appeared in Wallich's Catalogue of 1828 and was thus a *nomen nudum*. Hooker and Greville a little later, in 1828 or 1829, in their Icones Filicum, **1,** t. 79, published a plate of the species prepared from material supplied by Wallich. A description accompanied the plate and the species was thus validated.

The figure drawn by Greville, however, depicts a small plant very different in appearance from the modern concept of *B. lanuginosum* (see Plate II). A character which serves to distinguish this species from all other *Botrychia* is the unusual position of the fertile spike. It arises laterally from the main rachis in a position which, although it tends to vary from plant to plant, is always situated above the base of the blade. So significant has this feature been regarded by some workers that Clausen in his recent revision of the *Ophioglossaceae* (Mem. Torr. Bot. Club, **19,** no. 2 : 1938) has proposed a new section, the *Lanuginosae*, for the species. The Greville plate portrays a fertile spike arising from the base of the blade, coincident with the attachment of the two lowest pinnae. The general effect somewhat resembles *B. virginianum* and suspicions were aroused as to the actual identity of the plant figured. Efforts were made to locate the specimen, which was absent from the Hooker collections at Kew, and it was eventually discovered in the Greville herbarium at Edinburgh. A single sheet of the species contains two specimens, both purporting to represent Wallich's No. 48. One is a complete plant and bears little resemblance to Greville's drawing ; the other consists of a blade only and is undoubtedly the plant from which the upper part of Greville's drawing was prepared. The unusually small size of the blade and the apparent insertion of the fertile spike at the base were at first sight somewhat puzzling. A

PLATE II

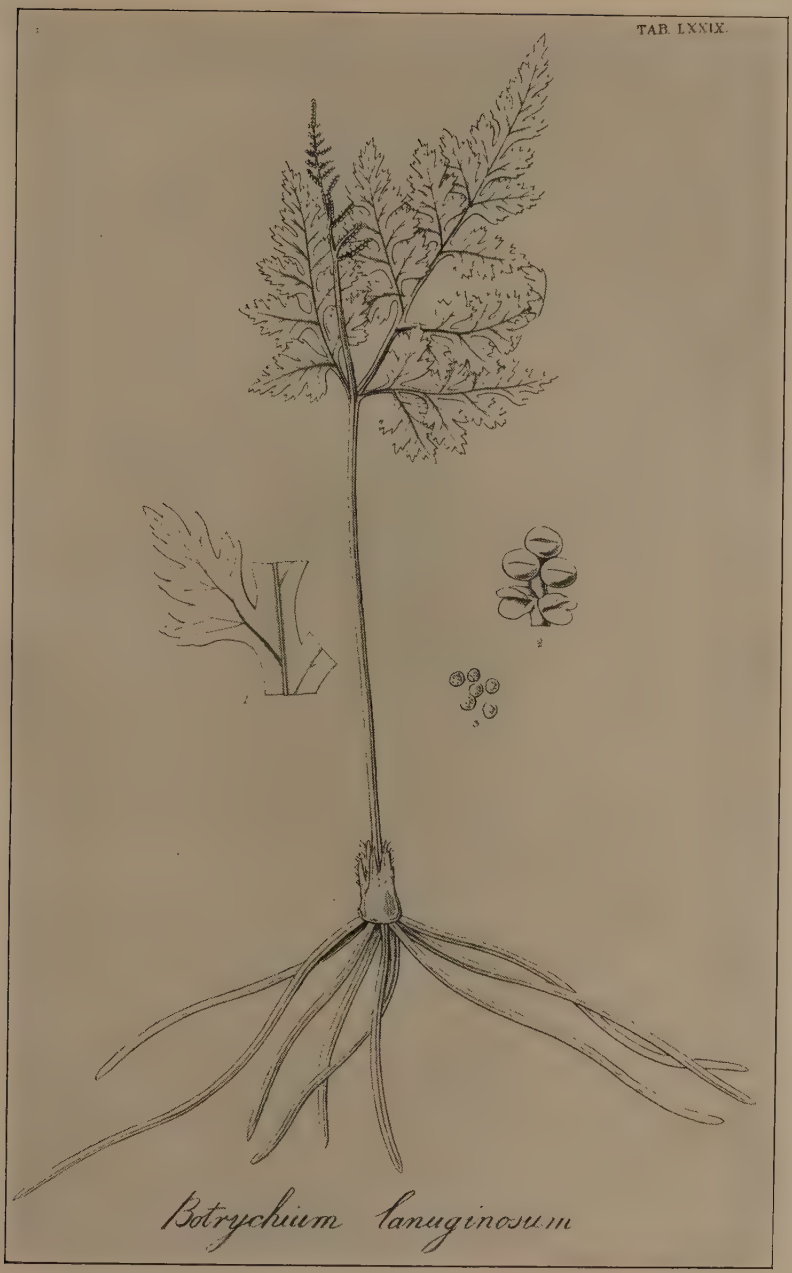

Figure of *Botrychium lanuginosum* Wall. ex Hook. et Grev., from Hooker and Greville's Icones Filicum, **1**, t.79.

[*To face page* 30

careful examination of the fertile spike, however, revealed the fact that the insertion was not at the base of the blade but at a point on the rachis about half an inch below it. The true state of affairs then became apparent. The natural assumption had been that the specimen represented a complete blade, whereas in reality only the uppermost portion, including the fertile spike, was present, the lower pinnae being missing.

One has to conclude, therefore, that in order to produce a drawing of a size convenient for reproduction, Greville combined, quite innocently, the incomplete frond just described with the basal portion of another specimen.

It seems strange that neither Hooker nor Greville attached any importance to the unusual position of the fertile spike. The point of insertion is not mentioned in the text accompanying the plate, although the authors admit having seen several specimens.

Dryopteris Wilsoni (Bak.) C. Chr. This was described by Baker as *Nephrodium Wilsoni* in Ann. Bot. **5,** 321 (1891) from an incomplete frond collected in Uganda near the shores of the Victoria Nyanza. The specimen is undoubtedly a large frond of **Arthropteris orientalis** (*Gmel.*) *Posth.*, although so little stipe is present that the articulation is missing. There are, however, obscure traces of lime-spots, a feature which is so characteristic of this species.

Polypodium Schneideri *G. Schneider.* This fern was raised in the late Messrs. Veitch's Chelsea nursery by G. Schneider and was claimed to be a hybrid between *P. aureum* L. and *P. vulgare* L. var. *elegantissimum.* The crossing was successfully repeated several times by Schneider, and Prof. J. B. Farmer, who investigated the structure of the hybrid (Ann. Bot. **11,** 533 : 1897), was satisfied of the validity of Schneider's claim. A description of the plant appeared in Schneider's " Book of Choice Ferns," **3,** 209 (1894) accompanied by a picture (p. 210). Christensen's reference in his Index Filicum (p. 562) is to a *nomen nudum.* In 1898, H. Christ described (Bull. Herb. Boiss. **6,** 835) a Sumatran plant as *P. Schneideri*, a name which is illegitimate according to the Rules of Nomenclature and for which another name has to be found. Since, however, it seems possible that the species is identical with *P. longissimum* Bl., no new name is proposed here.

III—PLANTS NEW TO ASSAM : XI.* C. E. C. Fischer.

Corydalis Borii C. *E. C. Fischer,* sp. nov. [Fumariaceae] ; *C. Chanetii* Lév. proxima, sed foliis haud longe petiolatis, pinnis utrinque 3–4, bracteis integris, sepalis haud cordatis, floribus majoribus differt.

Annual (?) glabrous *herb. Leaves* : basal not seen ; cauline several, sessile or nearly so, ovate in outline, 4–14 cm. long, 2–10 cm.

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* Continued from K.B. 1938, 213.

wide, pale below, pinnatisect, lobes 3–4 on each side, more or less decurrent on the midrib, elliptic, the terminal lanceolate, lobulate the lobules unequally 2–4-toothed, teeth acute or rounded. *Inflorescence* of terminal or terminal and lateral, few- to many-flowered racemes, 4–6 cm. long in flower, up to 17 cm. long in fruit, the lateral usually shorter; peduncles short; bracts lanceolate from a broad base which embraces the base of the pedicel, acute, 4–5 mm. long; pedicels 2·5–3 mm. long, lengthening in fruit. *Sepals* subcircular or broader than long, 0·75–1 mm. long, 1–1·5 mm. wide, delicate, erose-denticulate. *Corolla* including the spur 2·2–2·5 cm. long; *anterior petal* oblanceolate, obtuse, more or less boat-shaped, 9–10 mm. long; *posterior* cucullate, 8–9 mm. long with a nearly straight spur 1·4–1·5 cm. long; 2 *interior* oblong, obtuse, 5–5·5 mm. long, 2·5 mm. wide, cohering by their apices and joined at the base to the sides of the posterior petal, winged on the back along the midnerve and with a thick, broadly conical wing or fold along the lower $\frac{2}{3}$ of one of the lateral nerves. *Ovary* narrowly fusiform, 4–5 mm. long; ovules 8–10. *Capsules* (mature?) narrowly oblanceolate, 9–13 mm. long, 8–10 seeded.

NAGA HILLS: Chingkhu, 2400 m., fls. & frt. Dec., *N. L. Bor.* 6785 (type in Kew Herb.), "gregarious in oak forest"; Thekubama, 2100 m., fls. & frt. June, *Bor* 4456, "gregarious in deep evergreen forest, fls. orange-brown"; Pulebudze, 1500 m., fls. & frt. Aug., *Bor* 6349, "fls. orange."

Hypericum gracilipes *Stapf* ex *C. E. C. Fischer*, sp. nov. [Hypericaceae]; *H. Uralum* Ham. ex D. Don peraffinis, ramulis teretibus, venis foliorum supra impressis, bracteis anguste lanceolatis caudato-acuminatis, sepalis lanceolatis, stigmate capitellato differt.

A glabrous, branched *undershrub*; branchlets terete, brown. *Leaves* decussate, lanceolate to narrowly ovate, acute or subacute at both ends, 1·8–3·7 cm. long, 0·6–2 cm. wide, midrib and 3 pairs of primary nerves arising below the middle impressed above, slightly prominent below, the nerves inarching and anastomosing near the margins, secondary nerves and reticulations obscure, brown when dry, opaque so that the glands are inconspicuous; petioles 0 or very short. *Cymes* dichotomous, terminating the branchlets, up to 7-flowered; peduncle about 1 cm. long; bracts linear-lanceolate, caudate, up to 1·3 cm. long; bracteoles similar, shorter. *Sepals* 5, coriaceous, narrowly lanceolate, 8–8·5 mm. long, 1·8–2·2 mm. wide, subacute. *Petals* 5, broadly obovate to subrotund, slightly oblique, up to 1·6 cm. long and 1·4 cm. wide, apex rounded, yellow, thinly membranous with one margin subcoriaceous. *Stamens* numerous, in 5 bundles; filaments unequal, shorter than the petals. *Ovary* ellipsoid, 6 mm. long, 5-celled; ovules axile; styles 5, 5 mm. long, slender; stigmas capitulate. *Capsule* 1 cm. long.

LUSHAI HILLS: Neikdawn, on banks of stream, 1200 m., fls. & frt. July, *Mrs. N. E. Parry* 74 (type in Kew Herb.). NAGA HILLS: Kedima, on a sandstone slope, 1800 m., fls. July, *Bor* 6313.

Dr. O. Stapf had set Mrs. Parry's specimen aside as a new species to which he proposed to give the binomial adopted.

Ophiorrhiza tingens *C. B. Clark* ex *C. E. C. Fischer*, sp. nov. [Rubiaceae] ; *O. Mungos* Linn. accedens, stipulis multo longioribus, bracteolis persistentibus, capsulis minoribus differt.

An *undershrub* up to 30 cm. high (sometimes trailing and longer) ; stems terete, woody and glabrous below, simple or branched and more or less brown-puberulous above. *Leaves* lanceolate to ovate, rarely subrotund, acute to caudate-acuminate, tapered to the base and more or less decurrent, 9–17 cm. long, 3–6 cm. wide, glabrous above or with scattered very short hairs, more or less puberulous on the midrib and nerves below, midrib prominent below, primary nerves 10–14 pairs, slightly raised below, slightly arched, parallel, anastomosing near the margins, when dry usually dark-brown or olivaceous above, pale and often reddish below ; petioles 1–4 cm. long, brown-pubescent or glabrescent ; stipules narrowly ensiform, up to 1 cm. long, entire or more or less deeply 2-fid, apices filiform. *Inflorescence* terminal, 1·5–3 cm. long, lengthening in fruit, peduncles 1·5–7 cm. long, more or less densely brown-pubescent, bracts and bracteoles persistent, linear, up to 6 mm. long. *Calyx-tube* funnel-shaped, 1 mm. long, brown-puberulous ; lobes 5, lanceolate to ovate, acute, 0·2 mm. long. *Corolla-tube* cylindric, 4·5–8·5 mm. long, villous within just below the mouth ; lobes 5, oblong lanceolate, obtuse, 2–2·5 mm. long, puberulous within. *Stamens* 5, inserted at about the middle of the corolla-tube or close to the base ; filaments 0·5–1·5 mm. long ; anthers linear 1·6–2·3 mm. long. *Disk* of 2 fleshy, oblate, curved segments 0·5–1 mm. long, 1·5 mm. wide. *Style* slender, shorter than the longer stamens and included or up to 8·3 mm. long and shortly exserted, barbellate ; stigma flat, expanded, entire or bifid. *Capsules* 2–2·5 mm. long, 4·5–8 mm. wide.

Naga Hills : Kohima, 1800 m., fls. purplish, Oct., *C. B. Clarke* 41121 A (type in Kew Herb.) ; Kohima, 1260 m., fls. purple, May, D. Prain s.n. ; Tesangki, 1200 m., fls. white pink outside, May, *Bor* 2654 ; Benronmi, 1450 m., fls. white and frt. May, *Bor* 2669 ; Paona, 2500 m., fls. white and purple, end April, *Bor* 2751 ; Tesangki, 1450 m., fls. end April, *Bor* 2782 ; Konoma, 1700 m., fls. April, *King's Collector* 246. Nowgong, *Simons* s. n. ; *Jenkins* 4842. Garo Hills ; *Simons* s. n. Khasia : Burney Hut, 180 m., fls. nearly white, May, *Clarke* 38076 A ; Nungpo, 540 m., fls. lurid-purplish, early April, *Clarke* 43268. Burma : S. Mines, towards Kuwa, Boon, fls. May, *Griffith* Kew Distr. No. 2865.

Heterostyly seems to occur in this species, but more research in the field is necessary to establish the point.

C. B. Clarke recognised all the specimens listed above except those of Dr. N. L. Bor's as a new species and inscribed them with the combination accepted.

Ophiorrhiza Wattii *C. E. C. Fischer*, sp. nov. [Rubiaceae]; *O. cantonensi* Hance peraffinis, foliis apice basique sensim attenuatis, bracteolis longioribus latioribusque, corollis longioribus differt.

An *undershrub* up to 30 cm. high, unbranched in specimens seen; stem woody below, sulcate when dry. *Leaves* elliptic or elliptic-lanceolate, caudate, tapering to the base, 6–16·5 cm. long, 2·4–4·5 cm. wide, midrib impressed above, primary nerves 10–11 pairs, arched, parallel and joining the next above near the margin, a very fine vein running along the margin interrupted by a series of glands, dark above when dry, paler below, with scattered minute hairs on both faces especially near the margins and on the nerves, hardly visible without a lens; petioles slender, 1–3·5 cm. long; stipules not seen. *Inflorescence* terminal; peduncles 1·5–2·5 cm. long, with 2 lines of rufous pubescence; branchlets short, rufous-puberulous; bracts and bracteoles linear-lorate, finely acuminate, 4–12 mm. long; pedicels 1–2 mm. long, rufous-puberulous. *Calyx-tube* cupular, 1·5 mm. long, rufous-puberulous; lobes 5, ensiform, 1·5–2 mm. long. *Corolla-tube* cylindric, 1·3 cm. long, pubescent on the middle third within; lobes 5, oblong, rounded, 2 mm. long. *Stamens* 5, inserted about the middle of the corolla-tube; filaments slender, 3–4 mm. long; anthers basifixed, linear, 3·5 mm. long. *Disk* of 2 quadrate or trapezoid, fleshy, lobiculate segments 1–2 mm. long. *Style* slender, 3–4 mm. long; stigma ellipsoid, flat, 2·5–3·5 mm. long, entire or more or less deeply bifid. *Capsule* 2·5 mm. long, 6 mm. wide.

MANIPUR: in the forest around Sihorifuror, 1800 m., fls. and frt. April, *G. Watt* 6350 (type in Kew Herb.). NAGA HILLS: Shiloi Jopi, gregarious in oak forest at 2500 m. fls. white, Sept., *Bor* 6750. Watt recognised his specimen as a new species but did not publish a description; as the combination he proposed has since been used I have dedicated the species to him.

Tarenna Borii *C. E. C. Fischer*, sp. nov. [Rubiaceae]; *T. asiaticae* (Linn.) O. Ktze. affinis, foliis membranaceis, corymbis floribusque majoribus, pedicellis multo longioribus distincta.

A small, glabrous *tree*; ultimate twigs terete, grey-brown. *Leaves* lanceolate- or ovate-oblong, acuminate, base rounded or cuneate, 9–12 cm. long, 3·5–5·5 cm. wide, primary nerves 7–10 pairs, prominent below, glabrous except for a small group of hairs in each of the axils below; petioles 0·4–2·3 cm. long; stipules ensiform from a broad base, 6–7 mm. long, deciduous. *Corymbs* terminal with a few smaller from the upper axils, up to 6 cm. across; peduncles short; bracteoles 2 at the base of the pedicels, shortly united at the base, ovate, cuspidate, 2 mm. long; pedicels slender, 6–10 mm. long, black when dry. *Calyx* turbinate, 6–6·5 mm. long including the ovary; lobes 5, cuspidate, keeled at the apex, 2 mm. long, 3 mm. wide, margins sometimes minutely bristle-ciliate. *Corolla* hypocrateriform; tube cylindric, 6–8·5 mm. long, hairy within with pale-brown, crisped hairs; lobes 5, overlapping

clockwise, broadly oblong, often with a blunt tooth on one or both sides near the apex, 8·5–11 mm. long, 5–6 mm. wide. *Stamens* 5 ; anthers sessile on and partly exserted from the naked mouth of the corolla, 6–7 mm. long. *Ovary* 3·5–4 mm. long ; ovules ∞ ; style rather stout, 7–8 mm. long ; stigma exserted, fusiform, 5 mm. long, 1·5 mm. diam. *Fruit* not seen.

NAGA HILLS : Tesangki, 1625 m., fls. white, May, *Bor* 2653 (type in Kew Herb.) ; *Bor* 2644, without particulars, in Dehra Dun Herb.

Patrinia pentandra *C. E. C. Fischer*, sp. nov. [Valerianaceae] ; *P. monandrae* C. B. Clarke similis, caulibus fistulosis, foliis sessilibus, staminibus quinque differt.

A tall *herb* ; stem fistular, pale-brown, 6–7 mm. diam. *Leaves* sessile, pinnatisect nearly to the midrib, lobes 2–3 pairs and a terminal, the lowest pair very short, linear, entire, the next two narrowly elliptic-lanceolate or- oblanceolate, acute, 2·5–3·5 cm. long, 5–8 mm. wide, margins 2–3-toothed on each side, terminal lobe elliptic, acute at both ends, 8–11 cm. long, 3–4 cm. wide, coarsely, regularly toothed, primary nerves of lateral lobes 3 from the base, of the terminal 6–7 pairs, ultimate reticulations of all fine, glabrous or nearly so above, sparsely pubescent on the nerves below, ciliolate ; stipular ridge pubescent. *Panicles* terminal and axillary, the terminal up to 30 cm. long ; rhachis and its branches pubescent on one side ; floral leaves at the divisions like the cauline but smaller ; bracts linear, obtuse, 1·7–2·7 mm. long ; bracteoles 2 under the flower, subcircular, 2 mm. diam., serrulate. *Flowers* numerous, sessile. *Ovary* narrowly turbinate, 1·5 mm. long, puberulous, 3-celled. *Calyx* a mere, very short, entire rim. *Corolla* cupular ; tube 2·2 mm. long, villous within ; lobes 5, semicircular or oblong, 1·5 mm. long. *Stamens* 5, on the base of the corolla ; filaments 1·5 mm. long, glabrous or villous in the same flower ; anthers oblong, 0·6 mm. long, reddish, appressed-pubescent. *Style* slender, 2·5 mm. long, glabrous ; stigma capitate. *Fruit* ellipsoid, 3-gonous, crustaceous, 3 mm. long, hispidulous on the angles and the back, subequally 3-celled, posterior cell 1-seeded, the anterior 2 empty ; bract attached to the fruit papery, oblong or subcircular, strongly veined, 6·5–7·5 mm. long, 4–5·5 mm. wide.

NAGA HILLS : Lacham, 1100 m., fls. yellow and white, Sept., *N.L. Bor* 6733 (type in Kew Herb.). MANIPUR : Moa, frt. Oct., *C. B. Clarke* 41423A.

Myriactis assamensis *C. E. C. Fischer*, sp. nov. [Compositae] ; ab omnibus ceteris speciebus foliis minoribus angustis differt.

A much-branched *herb* 10–25 cm. high ; stems numerous from the base, glabrous below, dark-grey, sulcate. *Leaves* alternate, sessile, linear to linear-oblanceolate, acute, slightly narrowed to a semi-amplexicaul base, 1·5–2·7 cm. long, 2–3 mm. wide, margins entire or with an acute tooth on both sides a little below the apex

and often another pair lower down but above the middle, midrib slightly impressed above, slightly prominent below, lateral nerves obscure. *Capitula solitary*, terminating the branchlets, hemispheric, 3–4 mm. diam. ; peduncles slender, up to 7 cm. long, hispidulous, bearing a few reduced leaves which become smaller upwards. *Phyllaries* 2-ranked, thinly membranous, oblong, obtuse, minutely denticulate, 2–3 mm. long, the inner the larger, when dry olivaceous and minutely puberulous with pale scarious minutely ciliolate margins. *Receptacle* flat naked. *Ray florets* 2–3-seriate ; *ovary* linear to elliptic-oblanceolate and compressed, narrowed at both ends, 1·5–2 mm. long, glandular ; *ligules* linear, obtuse, 7–8 mm. long, white ; *style* short, shortly, bluntly 2-fid. *Disk florets* many, tubular, 2–2·5 mm. long ; *ovary* as in the ray florets ; *corolla* abruptly funnel-shaped above a short cylindric base, 2–2·5 mm. long, yellow ; lobes 4–5, triangular, acute, about half the length of the tube ; *stamens* 4–5, anthers short, oblong, apiculate ; *style* deeply 2-fid, lobes linear lanceolate, acute, minutely papillose outside. *Achenes* very narrowly oblanceolate, compressed, 3 mm. long, including a very short beak, dark-brown, glandular.

Naga Hills : Nahatomi, on rocks in Tizu River, 900 m. fls. Dept., *Bor* 6692 (type in Kew Herb.). Garo Hills : Nongwalbibra, among rocks in Somesiwari River, 725 m., fls. & frt. early Jan., *Mrs. N. E. Parry* 1229, Garo name : *Rongbikal*.

Saussurea nagensis *C. E. C. Fischer*, sp. nov. [Compositae] ; *S. deltoideae* (DC.) C. B. Clarke peraffinis, lobis terminalibus foliorum anguste lanceolatis, phyllariis basi valde incrassatis concavis distincta.

A tall *undershrub* ; stem more or less woody below, terete, sulcate, reddish and thinly cottony above (lower parts not seen). *Leaves* stiffly membranous, ovate in outline, acuminate, deeply pinnatisect, often to very near the midrib, 20–23 cm. long, 13–16 cm. wide, lobes 3–4 pairs with sometimes a very small detached pair below, lanceolate, acuminate, apiculate, margins, as also those of the long linear-lanceolate terminal lobe, sinuate-dentate with large and small apiculate teeth, the 2nd pair from the base the largest of the lateral lobes, midrib prominent on both faces, lateral nerves more or less prominent below ; upper surface dark-green, densely dotted with short, brown, crisped hairs, below grey-floccose, brownish on the nerves, basal lobes narrowly decurrent on the 2–3 cm. long, flocculent petiole, usually subtended by a small auricle. *Inflorescence* terminal, panicled, up to 30 cm. long, lateral branches racemose, up to 10 cm. long, 1–4-capitulate ; peduncles of solitary or terminal capitula up to 6·5 cm. long, of the rest 2–10 mm. long ; rhachis, its branches and the peduncles thinly tomentose ; bracts at the divisions of the rhachis and base of the peduncles linear-lanceolate to linear, up to 5 cm. long, the lower largest, more or less coarsely and sharply dentate, the upper much smaller and entire, indumentum as of the leaves. *Capitula* hemispheric, up

to 2 cm. diam.; phyllaries 6-seriate, 8·5–9·5 mm. long, the outer ensiform from a broad, much thickened, concave base 3·5 mm. diam., apiculate, cottony below, the upper part shortly dark-hairy, the inner bracts shorter and narrower with less thickened bases, the outer 2–3 rows recurved; receptacle flat, densely furnished with yellowish setae 2·4–5·6 mm. long. *Florets* all tubular. *Ovary* oblong, compressed with one side excavate (at least when dry) or more or less trigonous in section, shallowly ribbed, 3–3·5 mm. long, apex truncate with a raised, usually denticulate rim. *Pappus* 1-seriate, united into a ring at the base, 8–11 mm. long, white, plumose. *Corolla* 1 cm. long, mauve, lower half narrow-cylindric, upper very narrowly funnel-shaped; lobes 5 linear, acute, 2·7 mm. long. *Stamens* 5, anthers 4 mm. long, their tails 2 mm. long, nearly entire. *Style* 2-fid, arms plano-convex, obtuse. *Achenes* not seen.

NAGA HILLS: Phulani, on grassy slopes, 2150 m., fls. Sept., *Bor* 27.

Lobelia Handelii *E. Wimm.* [Campanulaceae].

Previous record from Yunnan.

NAGA HILLS: Japvo, 2900 m., fls. late Sept., *Bor* 6428.

Symplocos Ifsiana *C. E. C. Fischer*, sp. nov. [Symplocaceae]; proxima *S. cordifoliae* Thw., ramulis tomentosis, foliis papyraceis majoribus subtus pilosis, lobis calycis ovatis, stylo villoso, fructu hirsuto distat.

A small *tree*; youngest twigs brownish- or fuscous-tomentose; branchlets finely furrowed, brown, glabrescent. *Leaves* papery, elliptic or elliptic-oblong, rarely elliptic-oblanceolate, acuminate, base rounded or cuneate, the apex sometimes falcate, 10–20 cm. long, 4·5–7·5 cm. wide, midrib and 9–11 pairs of primary nerves impressed above, prominent below, the nerves anastomosing near the margins, secondary nerves scalariform, margins closely denticulate with linear teeth callous at the tip, upper surface glabrous except for the hairy midrib and usually the primary nerves also at least near their bases, below pilose on the midrib, nerves and nervules; petioles terete, 8–13 mm. long, brown- or fuscous-tomentose. *Racemes* simple, from the apical axils, 3–5 cm. long; rhachis grey- or brownish-tomentose; flowers crowded, sessile; bracts broadly ovate, obtuse 5–6 mm. long, villous without, ciliate; bracteoles similar but smaller and sometimes apiculate. *Calyx-tube* very short above the ovary; lobes 5, ovate, obtuse, densely grey-villous as is the tube without, 3·5 mm. long. *Corolla-tube* very short; lobes 5, elliptic-oblong, obtuse or subacute, pale-yellow (when dry), 8–8·5 mm. long, thinly pubescent on the lower half and on the tube without. *Stamens* 70-80; filaments slender, glabrous, 7·5–9·5 mm. long, united at the very base and adhering to the corolla-tube, not pentadelphous; anthers broadly oblong, 0·7 mm. long. *Ovary* cupular, 1·5 mm. long, densely grey-villous, 3-celled; style 7·5 mm. long, villous in the lower $\frac{2}{3}$. *Fruit* oblong,

1–1·15 cm. long, 5–6 mm. diam., crowned by the calyx, very dark-green (when dry), brown-hairy.

Naga Hills: Thevopesimi, in evergreen forest, 2170 m., fls. Sept., *Bor* 22 (type in Kew Herb.); Kamku Range, 2170., frt. March, *Bor* 2932.

The names of several Forest Officers in India have been commemorated in the names given to genera and species of Indian plants, but none have been dedicated to the Indian Forest Service (I.F.S.) as a whole and I take the liberty of doing so in this case.

Symplocos nagensis *C. E. C. Fischer*, sp. nov. [Symplocaceae]; *S. ramosissimae* Wall. affinis, ramulis hornotinis tomentosis, foliis angustioribus, costa subtus pilosa, staminibus multo numerosioribus differt.

A small *tree*; youngest twigs closely brown-tomentose, the older slender, dark-brown, finely furrowed (when dry), glabrous. *Leaves* elliptic to elliptic-oblong, acuminate, base cuneate, 5·5–9·2 cm. long, 2–3 cm. wide, midrib prominent below, primary nerves 7–8 pairs, above shining and glabrous except for the puberulous midrib, below dull and with scattered hairs when young, soon becoming glabrous except for the permanently hirsute midrib, margins slightly revolute, sharply serrate except for the lower $\frac{1}{5}$–$\frac{1}{3}$ and the apex, the teeth callous-tipped; petioles slightly compressed, 3–5 mm. long, hairy. *Racemes* from the upper axils, 2–7-flowered; peduncle 1 cm. long, densely appressed-pubescent, brownish near the base, greyish upwards; bracts ovate, 1 mm. long, pubescent outside; pedicels 2–4 mm. long, appressed grey-pubescent; bracteoles 2, opposite, at the base of the ovary, similar to the bracts. *Calyx* with ovary turbinate, 2·8 mm. long, pubescent; lobes 5, subsemicircular, 1 mm. long. *Corolla* 4 mm. long, cream-coloured; lobes 5, very shortly united at the base, broadly ovate, obtuse, glabrous. *Stamens* over 100, very slightly pentadelphous; filaments slender, up to 5 mm. long, glabrous. *Ovary* 2-celled; style 7 mm. long, glabrous. *Fruit* not seen.

Naga Hills: Kanjang, 2350 m., fls. Sept., *Bor* 6745.

Wrightia sikkimensis *Gamble* [Apocynaceae].

Known from Sikkim.

Naga Hills: Jotsoma, 1450 m., fls. May, *N. L. Bor* 6363, "Climber; flowers reddish." Though this is a climber, it is not otherwise distinguishable from the plant described by Gamble.

Onosma Borii *C. E. C. Fischer*, sp. nov. [Boraginaceae]; *O. multiramosae* Hand.-Mzt. peraffinis, cymis terminalibus et axillaribus, calycis tubo distincto, corolla calyce satis longiore, filamentis latis, disci praesentia distat.

Erect *herb*; twigs pale grey-brown, setose with patent hairs from tubercular bases mixed with short adpressed bristles (lower parts not seen). Basal *leaves* in a rosette lying procumbent (fide N. L.

Bor) ; upper cauline sessile or very shortly petioled, narrowly lanceolate, acute or subacute, base rounded, 2·7–5·3 cm. long, 6–12 mm. wide, midrib impressed above, prominent below, lateral nerves 3 pairs, arising at a very acute angle, obscure, above dark-green rough with long setae from tubercular bases, which latter eventually appear as white dots, mixed with shorter ones, below greyish and harsh with long setae from tubercles on the midrib, the rest densely covered with long and short stiff hairs, margins revolute. *Cymes* dichotomous, terminal and from the upper axils, up to 4 cm. long ; rhachis and its branches setose like the twigs ; bracts and bracteoles like the leaves but much smaller, similarly setose ; pedicels 4–10 mm. long, setose. *Calyx* cupular, setose from tubercles mixed with short appressed bristles without, densely appressed white-setose within ; tube 3·2–4·5 mm. long ; lobes lanceolate, acuminate, 5·5–6·5 mm. long. *Corolla* narrowly barrel-shaped ; tube 1·55 cm. long, retrorsely hispid without, hairy below the stamens within ; lobes triangular-ovate, obtuse, 1–1·2 mm. long. *Stamens* inserted just below the middle of the corolla ; filaments flat, broad, 3·7–4 mm. long, hairy at the base ; anthers included, cohering by their bases into a cone, linear-ensiform, introrse, 6 mm. long including the beak, margins and apex minutely spinulose, *Disk* annular, thinly membranous, 1·5 mm. long. *Ovary*-lobes lobulate, 1 mm. long ; style slender, 1·65 cm. long, shortly exserted ; stigma capitate, minute. *Fruit* not seen.

Naga Hills : Laruri, 1230 m. and Shiloi Jopi, 2450 m., fls. Sept., *N. L. Bor.* 39 (type in Kew Herb.). " Fls. blue changing to pink at the corolla-mouth."

Onosma lycopsioides *C. E. C. Fischer*, sp. nov. [Boraginaceae] ; *O. Borii* C. E. C. Fischer affinis, ramulis fuscis, foliis elliptico-oblongis distat.

Erect *herb* (lower parts not seen) ; twigs terete, dark-brown, covered with spreading whitish or brownish setae from tubercular bases mixed with shorter hairs. Upper cauline *leaves* sessile elliptic-oblong, acute, narrowed to the base, 5·5–12 cm. long, 1·3–3·5 cm. wide, lateral nerves obscure, upper surface dark-brown when dry, whitish-setose from tubercular bases which latter eventually appear as white discs, below pale and furnished with softer setae from smaller tubercles, denser on the nerves. *Cymes* terminal and from the upper axils ; peduncles up to 10 cm. long, setose like the twigs, partial rhachises and pedicels ; bracts like the leaves but much smaller, sometimes ovate ; bracteoles at the base of the pedicels linear to linear-lanceolate, finely acuminate, sessile, 5–10 mm. long, white-setose ; pedicels 5–10 mm. long. *Calyx* turbinate ; tube 3·7–4 mm. long ; lobes lanceolate, acute, 5·5 mm. long, patently densely white-setose from tubercular bases outside, densely appressedly white-setose within. *Corolla* barrel-shaped from a very short cylindric base 1·7 cm. long, retrorsely hispid without, glabrous within except for a zone of hairs about the

base of the stamens ; lobes ovate, obtuse, 1·5 mm. long. *Stamens* inserted about ⅓ above the base of the corolla ; filaments ensiform, 6 mm. long, brown-hirsute at the base ; anthers included, cohering by their bases, introrse, narrowly linear-lanceolate, dorsifixed, 6 mm. long including the beak, margins and apex minutely spinulose. *Disk* annular, thinly membranous, 2 mm. long, apex 8-lobulate. *Ovary* 1 mm. long ; style slender, glabrous, 1·6 mm. long, shortly exserted ; stigma capitate, minute. *Fruit* not seen.

NAGA HILLS : Japvo, 3050 m., fls. Sept., *N. L. Bor* 6507 (type in Kew Herb.) " Flowers bluish-purple."

In Kew Bull. 1938, 211, this same specimen was erroneously cited as *Lycopsis arvensis* Linn. which it closely resembles in its vegetative parts. The specimen was devoid of corollas, stamens and nutlets so that the main points of difference between the two genera were lacking. Subsequently further samples of the same collection were received and the error could then be corrected.

Wulfenia Amherstiana *Benth.* [Scrophulariaceae].

Known from the Western Himalayas from Afganistan to Kumaon.

KHASIA AND JAINTEA HILLS : Lawlyngdoh, 1800 m., fls. Sept., *fide* Dr. N. L. Bor *in litt.* (specimens in Dehra Dun & Shillong Herbaria).

Chirita Trailliana *Forr. et W. W. Smith* [Gesneriaceae].

Recorded from W. China.

NAGA HILLS : Kilomi, 1850 m., fls. June. *N. L. Bor* 4482.

Didymocarpus yunnanensis (*Franch.*) *C. E. C. Fischer*, comb. nov. [Gesneriaceae]. *Rottlera yunnanensis* Franch. in Bull. Mus. Hist. Nat. Paris, **5**, 250 (1899)—a Yunnan plant.

NAGA HILLS : Pulebudze, 1540 m., fls. Aug., *N. L. Bor* 6346.

Aeschynanthus oblanceolata (*Anth.*) *C. E. C. Fischer*, stat. nov. [Gesneriaceae] ; *A. bracteatae* Wall. affinis, foliis oblanceolatis cuspidatis minoribus, bracteis minoribus, filamentis haud exsertis differt.

A glabrous epiphytic *shrub* 0·4–1·6 m. long, pendulous ; branches pale- to dark-brown, 2 mm. diam. or more, woody. Leaves oblanceolate, sometimes elliptic-oblanceolate, abruptly cuspidate, subacute, base tapered, 4–7 cm. long, 1·3–2·5 cm. wide, midrib impressed above, raised below, nerves invisible, margins more or less revolute ; petioles 6–10 mm. long canaliculate above. *Inflorescence* in the upper axils, sometimes appearing terminal through the arrest of the terminal buds ; peduncles solitary or twin, 3–6 cm. long, 1–2-flowered, with minute, thick, broadly ovate, apiculate bracts at the base ; bracteoles ovate or ovate-lanceolate, obtuse or subacute, 1–1·6 cm. long ; pedicels 0·5–2 cm. long. *Sepals* 5 , narrowly oblong, obtuse or subacute, 1·4–2 cm. long. *Corolla* tubular, curved, slightly ventricose ; tube 3·2–3·5 cm. long ; limb 2-lipped, posterior lip of 2 broadly oblong, rounded lobes 3–4 mm.

long, anterior 3-lobes, lobes broadly oblong, 4–6 mm. long, midlobe longest. *Stamens* 4 ; filaments slender, 1·3–1·6 cm. long, puberulous towards the apex, inserted about the middle of the corolla-tube, those of the anterior a little lower than the posterior and a little longer ; anthers oblong, 2–2·5 mm. long, united in pairs by their apices in the corolla-mouth. *Disk* annular, lobulate, 2 mm. long. *Ovary* stipitate ; stipe 1·2–1·6 cm. long ; carpel linear, 1·1–1·3 cm. long ; style 4–5 mm. long ; stigma widely funnel-shaped. *Fruit* and *seeds* not seen.

Naga Hills : Pulebudze, 2530 m., fls. Aug., *N. L. Bor* 6345, " flowers plum-coloured, mouth spotted." N. E. Burma : " on rocks and trees in mixed forests," 2530–2900 m., fls. Sept. *G. Forrest* 24935 (type in Edin. Herb., duplicate in Kew Herb.) " pendulous epiphytic plant of 1–2 ft. ; flowers brilliant scarlet-crimson " ; 26° 14′ N. : 98° 46′ E., on trees in forests on the lower ridges of the divide. 2530–2900 m., fls. July, *Forrest* 27080, " Epiphytic plant of 1–4 ft. Flowers deep crimson."

Besides the colouring of the flowers I can see no differences between the three collections except that in the last cited the leaves are more coriaceous and some of them (the lower ones) smaller and more elliptic. In all three in the dry state the bracteoles and the sepals appear to be concolorous with the corolla.

In Not. R. Bot. Gard. Edinb. **18,** 190, Anthony has published the combination *Aeschynanthus Peelii* Hook. f. et T. var. *oblanceolata* Anth. citing *Forrest* 24933 & 27080. I consider that the differences between these and the type of the species, as also of *A. bracteata* Wall. are sufficiently pronounced to merit elevation to specific rank ; indeed they are greater than those Anthony (l.c.) indicates between the two older species, which, he thinks, were wrongly merged by C. B. Clarke in Fl. Brit. Ind. **4,** 342. I am not prepared to express an opinion on this point as the type of *A. bracteata* (Wall. Cat. 794) is not available at the moment. A rather poor duplicate of it, however, shows that one of Anthony's points of difference—the relative length of the peduncles and petioles—is not valid. *A. oblanceolata* (Anth.) Fisch. diverges more from either of the two older species than they do from each other. One character showing a marked difference is not mentioned by Anthony. In both the older species the stamens are well-exserted from the corolla, in the new one the anthers are in the corolla-mouth. (I have not seen the Edinburgh sheets, but duplicates of the 2 cited are in the Kew Herbarium.)

Lysionotus gracilipes *C. E. C. Fischer*, sp. nov. [Gesneriaceae] ; *L. pubescenti* C. B. Clarke peraffinis, caulibus anisophyllis, foliis ellipticis minoribus subtus pubescentibus, capsula graciliore differt.

Epiphytic *undershrub* ; branchlets more or less compressed, brown, glabrous below, brown-tomentose upwards. *Leaves* thinly coriaceous, opposite or ternate, rarely alternate, narrowly elliptic or elliptic-lanceolate, acute at both ends, 2·5–6·5 cm. long, 0·5–1·7 cm.

wide, those at the same node unequal, primary nerves 4–6 pairs, glabrous above, thinly clothed with multicellular hairs below, margins sinuate; petioles terete, 1–4 mm. long, tomentose. *Inflorescence* axillary, of 3–6-flowered umbels, one or two branches of the umbels often 2-flowered; peduncles filiform, up to 11 cm. long; bracts at the base of the umbel 2, ovate, obtuse, 3 mm. long, glabrous; bracteoles similar, smaller. *Sepals* 5, oblong-lanceolate, subacute, bluntly apiculate, 5 mm. long, 1·5 mm. wide, 3-nerved. *Corolla* tubular-ventricose, white, thinly pubescent outside; tube 3·2 cm. long; limb 2-lipped; anterior lip of 2 oblate, rounded lobes 2·5 mm. long, 5 mm. wide, with 2 folds in the throat 6 mm. long, 2 mm. wide, tapering in front, semi-cordate at the base; posterior lip 3-lobed, 1·3–1·5 cm. long, terminal lobe oblong, 6 mm. long, lateral broadly ovate, 5 mm. long. *Stamens* 2, included; filaments inserted just above the middle of the corolla-tube, flat, curved towards the apex, 1·2 cm. long; anthers sub-circular, 1·6 mm. diam., confluent. *Disk* annular, lobiculate, 1·3 mm. long. *Ovary* shortly stipitate, linear, 1·5 cm. long; style compressed, 8·5 mm. long; stigma hardly wider. *Capsules* slender, acuminate, 5–6 cm. long. *Seeds* not seen.

Naga Hills: Kohima, 2350 m., fls. & frt. Aug. *N. L. Bor* 6232 (type in Kew Herb.).

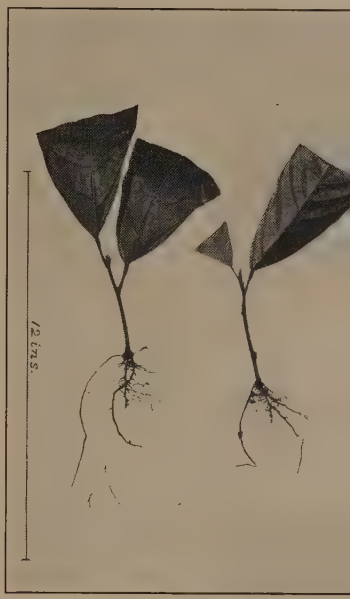
IV—NOTE ON THE VEGETATIVE PROPAGATION OF CACAO AT KEW. G. Evans.

For some years past the Royal Botanic Gardens have been actively concerned in the transfer of cacao plant material from one part of the British Empire to another.

The West African cacao growing colonies, Nigeria and the Gold Coast, have for some time been interested in the results obtained by the cacao research workers at the Imperial College of Tropical Agriculture in Trinidad and have been desirous of obtaining plant material from the selected clones of high grade "Forestero" cacao that have been one of the results of this research. West Coast cacao is of lower quality than the West Indian types which usually contain a proportion of "Criollo" or "*pentagona*" blood and command higher prices in the world's market.

There are, however, certain serious diseases in the West Indies, such as the "witches broom" caused by *Marasmius perniciosus*, which do not occur in West Africa, and in order to avoid the risk of their introduction the West African colonies are naturally taking all precautions, and consequently the Governments have prohibited the direct importation of all living cacao material. It is for this reason that the good offices of Kew have been sought and any material from the West Indies has now to come to the Royal Botanic Gardens in the first place, where it is grown in quarantine under supervision and is not released until it has been inspected by the officers of the Imperial Mycological Institute.

1.



2.

3.

Fig. 1. Soft-wood cuttings of cacao; cutting on left trimmed ready for potting.
Fig. 2. Cuttings showing root development after three months.
Fig. 3. Method of propagation in pots.

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Different kinds of material have been handled by Kew in the last two or three years. Seedlings have been raised from pods sent from Trinidad and from Nigeria, and the technique for the transportation of pods, to ensure that the seed is viable on arrival, has been developed.

Experiments in budding have also been made and a number of seedling plants raised from Nigerian seed have been used as root stocks and have been successfully budded.

It must be remembered, however, that Kew is working under some difficulty, since the cacao plants have to be raised in tropical houses where accommodation is strictly limited. In addition, because of weather conditions, the opportunity for exporting plants is restricted to the four summer months, and available space may, therefore, be severely taxed at certain times of the year. As several hundred plants are wanted by the West African colonies, it is important to devise a method whereby the required material can be raised and exported as rapidly as possible, and to send off the plants as soon as they are strong enough to travel. The smaller the plants, the less space will they occupy and the larger will be the number that can be packed into a Wardian case. This would result not only in a speeding up of operations, but also in a saving in the cost of packing and shipping. For these reasons, it was decided, in the autumn of 1939, to carry out experiments to test the possibility of rooting cuttings. As these have given better results than were anticipated, it should be of value to place on record the results of the first preliminary trials.

In Trinidad, cacao has been successfully rooted for some years past and cuttings of semi-hard wood, 7 or 8 inches in length, and about as thick as a lead pencil, are used. This system could possibly be adopted in Kew, but it has certain disadvantages. In the first place a good deal of material is required, and space at Kew is naturally limited, and secondly, the rooted plants are somewhat large and so occupy too much space in a Wardian case.

It was, therefore, determined to try and root young slips. The material used in the experiment (see Plate III) consisted of young soft-wood cuttings or slips, not thicker than a programme pencil, bearing only three or four fully developed leaves. These were taken from side shoots of clonal plants on their own roots received from Trinidad about a year ago, which are now growing in pots in the tropical houses at Kew. The cuttings taken are only about four inches in length, and about half the length is buried in the soil. It seems to be immaterial whether the cutting is made at the node or not, or whether a small heel of maturer wood from the main branch is attached.

The cuttings were planted in the regular compost used at Kew which consists of about two parts loam to one of sand and one of black peat. So far no plant growth substances have been used, but it is possible that these may be tried in future experiments.

Twenty cuttings were taken and after the leaf surface had been reduced, they were potted into 2 inch pots on 9th October, 1939. The pots were placed in a small case or wooden frame with a glass top about 4 ft. by 4 ft. in size, and this contained a 5 inch layer of coconut fibre, overlying a hot water tank at a temperature of about 115° to supply bottom heat. This case is one of several in the tropical pits in which the temperature varies between 75° and 85° and where the humidity is kept as high as possible, being usually between 70 and 80.

Callus rapidly formed and the first signs of rooting appeared early in November. On 11th January, 1940 (when the accompanying photographs were taken), the majority of the cuttings had rooted most satisfactorily, some of the roots being 5 inches long. At the same time growth above ground had commenced and the leading shoot was often over an inch in length with new leaves unfolding.

Of the twenty cuttings potted in October fifteen were well rooted and had begun to put on growth by the beginning of January. Ten of these were of I.C.S.1 and five of I.C.S.7, which are the two Trinidad clones at present available in Kew. There seems to be little difference between " fan " or " chupon " cuttings in the matter of striking, as nine of the rooted plants are from " chupons " and six are from " fan " shoots.

The experiments, so far as they go, are distinctly promising because it must be remembered that the period covered by them is probably the worst of the whole year for the purpose, owing to the prevalence of fog and the scarcity of sunlight. It seems likely that even better results may be obtained in the spring as the daylight improves, and it is also hoped that the time required to raise a stock of rooted plants fit to travel will be shortened.

There seems a possibility that by using the method described above, smaller, sturdier plants, occupying less space in a Wardian case, and less liable to damage in transit than budded plants, may be produced. The process is also far simpler and involves much less labour and greenhouse space than does the budding method.

V—NEW OR LITTLE-KNOWN PLANTS FROM SOUTHERN INDIA : XII.* C. E. C. Fischer.

Centratherum indicum (*Less.*) *C. E. C. Fischer*, comb. nov. [Compositae].

The combination *Centratherum reticulatum* (DC.) Benth. has been generally adopted for this plant, this epithet having been transferred from *Decaneurum reticulatum* DC. in Wight Contrib. Bot. Ind. 7, 1834. But as this publication was antedated by *Amphereph is indica* Lessing in Linnaea, **6**, 687, 1831, the epithet *indica* must be retained.

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* Continued from K.B. 1939, 662.

Centratherum Mayurii *C. E. C. Fischer*, sp. nov. [Compositae]; *C. indico* (Less.) C. E. C. Fisch. affine, foliis ellipticis vel elliptico-oblanceolatis haud rugulosis haud reticulatis, involucri bracteis lineari-lanceolatis distinctum.

A robust *herb*; stem terete, branched above, brown, striate, more or less densely furnished with multicellular black-banded (when dry) hairs from small, black tubercles. *Leaves* alternate, cauline (lower parts not seen) elliptic-oblanceolate, acute, base decurrent, 4–6·5 cm. long, 1–2·5 cm. wide, dark brown (when dry) above and abundantly furnished with crisped, pale-brown, multicellular hairs, below white-tomentose except the glabrous, brownish midrib and 9–10 pairs of parallel primary nerves, secondary nerves scalariform, obscure, margins sharply serrate; petioles up to 5 mm. long; uppermost leaves sessile, narrowly elliptic-lanceolate, margins nearly entire, otherwise like the lower. *Capitula* solitary, axillary on short peduncles or terminating leafless twigs, campanulate, 1 cm. diam., subtended by 2–3 leafy, apiculate, setose-ciliate bracts resembling the upper leaves, up to 2·5 cm. long. *Involucral bracts* 5-seriate, linear-lanceolate, pungently acuminate, 7·5–10·5 mm. long, innermost longest, the outermost with similar indumentum to that of the leafy bracts, the next 2 rows with the indumentum only in the apical half, the rest of the rows glabrous. *Receptacle* flat, naked. *Ovary* oblong, slightly obovate, 1·4 mm. long, 10-ribbed, glabrous. *Pappus* copious, white, 4·3–5 mm. long, of ascendingly long-barbellate setae. *Corolla* purple; tube filiform, very slightly expanded at the mouth 5·5 mm. long; lobes 5, linear, 1·5 mm. long. *Anthers* linear, base minutely 2-apiculate, 1·3 mm. long. *Style-arms* 2, linear, subacute, puberulous. *Achenes* like the ovary, pale-brown, 1·5–1·7 mm. long.

Mysore State: Kemmangundi Hills, fls. and frt. Nov., *P. V. Mayuranathan* without number (type in Kew Herb.).

The species is named in honour of the collector.

Senecio kundaicus *C. E. C. Fischer*, sp. nov. [Compositae]; *S. Wightii* (DC.) C. B. Clarke peraffinis, caulibus sparse puberulis, foliis lineari-oblongis obtusis minute dentatis, involucri bracteis numeriosioribus apice penicillatis, ligula 4-nervata pappo instructa differt.

A nearly glabrous *herb*; stem sulcate, sparsely puberulous. *Leaves* alternate, upper cauline (lower parts not seen) sessile, linear-oblong, apex rounded, base amplexicaul, auricles rounded, 6–12 cm. long, 1–2·1 cm. wide, primary nerves about 10 pairs, obscure, margins minutely, rather distantly toothed; the terminal leaf smaller and subacute, forming a bract to the corymb. *Corymbs* terminal, few-capitulate; bracts at the divisions similar to the terminal leaf but much smaller. *Capitula* turbinate, 5–6 mm. diam. *Involucral bracts* about 30 in 1 series with 1–2 shorter at the base, linear, obtuse or subacute, 7–7·5 mm. long, glabrous except the penicillate tips. *Receptacle* flat, naked, smooth. *Ray florets* few

in 1 row ; ovary linear-oblong, truncate, shallowly ribbed, 1·5 mm. long, glabrous, apparently fertile ; *pappus* ample, white, 5 mm. long ; *ligule* yellow, tubular portion very slender, 4 mm. long, limb elliptic-oblong, shortly 3-toothed and 4-nerved with the 2 central nerves forking near the apex and joining each other and the lateral in the teeth or 2-toothed with one lateral nerve evanescent near the apex and only one of the remaining central ones forking, 6·5 mm. long, 3 mm. wide ; *style-arms* 2, slender. *Disk florets* numerous, yellow ; *ovary* and *pappus* as in the ray florets ; *corolla* 5 mm. long, tube slender below, narrowly funnel-shaped in the upper third, lobes 5, triangular, acute, short, *anthers linear*, 1·5 mm. long, acute, base minutely 2-apiculate ; *style* shortly exserted, arms 2, short, truncate. *Achenes* not seen.

NILGIRI HILLS, on the Kundahs, fls. Sept., *P. V. Mayuranathan* without number (type in Kew Herb.).

VI—MISCELLANEOUS NOTES.

The Professorship of Forestry at Oxford.—MR. H. G. CHAMPION, M.A., I.F.S. has been elected to the Chair of Forestry at the University of Oxford in succession to the late Professor R. S. Troup, C.I.E., D.Sc., F.R.S. Mr. Champion has served with distinction for over 25 years in the Indian Forest Service. He was at one time Silviculturist at the Forest Research Institute at Dehra Dun and lately acted as Conservator of Forests in the United Provinces.

Mr. J. R. Sealy.—MR. J. R. SEALY, B.Sc., has been appointed by the Minister of Agriculture and Fisheries to the post of Assistant Botanist (Temporary) as from January 1st, 1940. Mr. Sealy has been assistant to the Editor of the Botanical Magazine since 1927.

SIDNEY ALFRED SKAN.—We record with deep regret the death on December 19th, 1939, at the age of 69, of Mr. S. A. Skan, who retired from the post of Botanist at the Herbarium in 1933 (K.B. 1933, 462).

Skan was born on August 30th, 1870, and received his early horticultural training at the Edgbaston Botanic Garden, under Mr. W. B. Latham. Mr. Latham, who had been trained at Kew, was an extremely successful horticultural instructor, and Skan was one of five young gardeners who came to Kew from Edgbaston during the nineties of last century.

Skan entered Kew as a Student Gardener on September 19th, 1892, and after working in the Arboretum and Temperate House pits, he sat for a competitive examination in 1894 for a post as Assistant in the Herbarium. He had always shown an interest in the botanical side of his work and he was very anxious to seize this chance of a botanical career. He worked every spare minute for six weeks before the examination and came out head of the list.

He was appointed Assistant on July 16th, 1894, and relieved Hemsley (then Principal Assistant) of the routine work of the Library; this absorbed the major part of his time and energies to the end of his career. After 1899 he was, in fact, Librarian, though he was not actually given this title. He was responsible for the annual lists of additions to the Library from 1899 to 1916, and for the Supplement to the Library Catalogue published in 1919.

Among the reforms effected by Skan was the rearrangement of the main body of the tracts in a single alphabetical series, thus greatly facilitating consultation. The maintenance of the Library in a satisfactory condition and its judicious expansion were due largely to his unceasing care and skill. His devotion to the interests of the Library naturally left him but little time for scientific work. Nevertheless, he elaborated the *Juglandaceae*, *Cupuliferae-Quercineae*, *Ceratophyllaceae* and *Gnetaceae* for the "Index Florae Sinensis" (1899), and (with Hemsley) prepared the account of the *Scrophulariaceae* for the "Flora of Tropical Africa" (1906), describing 54 of the 59 new species. He retained his interest in horticulture, and contributed a series of annual lists of plants introduced into cultivation during the period 1897–1915. Their discontinuance removed a valuable source of information on the history of garden plants. A list of his publications up to the year 1906 is given in Kew Bull. 1907, App. 5, p. 136.

Skan's exceptionally good memory and very wide knowledge of botanical literature were always placed freely at the disposal of his colleagues and of visitors to Kew, and he often went to great trouble to help junior members of the staff in their difficulties, whether these were concerned with identifying some garden plant or in tracing an obscure reference. He will be remembered as an example of devotion to duty, and for consistently placing the interests of Kew before his own.

Scientific Collaboration between Britain and France.—Two members of the Delegation from the Centre National de la Recherche Scientifique, Professor L. Blaringhem, Professor of Botany at the Sorbonne, and Professor P. Chouard, Professor of Agriculture at the Conservatoire National des Arts et Métiers, visited Kew on Tuesday, January 30th, after an earlier visit to the John Innes Horticultural Institution at Merton. They were met by the Director and discussed co-operation in various fields with Dr. Metcalfe, and with Dr. Tincker, who came from Wisley to meet them. They also visited the Herbarium after a general tour of the Gardens.

Botanical Magazine.—Part 3 of vol. 162, which was published on December 30th, 1939, contains the following plant portraits: *Astragalus Durhamii* Turrill (t. 9579), a fine yellow-flowered species found by Lt.-Col. F. R. Durham on the Gallipoli Peninsula;

Calorhabdos Brunoniana Bentham (t. 9580), a native of the East Central Himalaya and South-West China ; *Codonopsis convolvulacea* Kurz var. *Forrestii* (Diels) Ballard (t. 9581), a new variety from Yunnan and Szechwan ; *Leptospermum scoparium* J. R. et G. Forster var. *eximium* B. L. Burtt (t. 9582), a striking large-flowered new variety from Tasmania introduced by Mr. H. F. Comber ; *Crocus Sieheanus* Hort. Barr. ex B. L. Burtt (t. 9583), a new species or hybrid from the Taurus Mountains ; *Primula laciniata* Pax & K. Hoffm. (t. 9584), a native of West Szechwan ; *Leucojum trichophyllum* Schousboe (t. 9585), a dainty species found in Southern Portugal, Spain and the littoral regions of Morocco and Algeria ; *Nymphaea polychroma* A. Peter (t. 9586) a fine blue-flowered water-lily from Tanganyika Territory ; *Rhododendron fulvum* Balf. f. & W. W. Sm. (t. 9587), distributed from W. Yunnan to Upper Burma ; *Osbeckia yunnanensis* Franchet ex Craib (t. 9588), discovered by Delavay and found in Yunnan, Hupeh and Kweichow ; and *Arisaema sikokianum* Franchet & Savatier (t. 9589), a native of the island of Shikoku, Japan.

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